MACHINERY.

January, 1903.

IMPORTANT GAS-ENGINE INSTALLATION.

THE FIRST OF TWENTY-FOUR ENGINES AGGREGATING 40,000 H. P. NOW IN OPERATION AT BUFFALO—BLAST FURNACE GAS USED.

The illustration on this page is of a 1,000 horse power gas engine of the Koerting type, well-known in Europe, recently built by the De La Vergne Refrigerating Machine Co., New York, for the Lackawanna Steel Co., at Buffalo. This fact in itself may have no special significance, but there are certain features connected with this installation which make the engine of unusual interest and possibly of sufficient importance to say that it marks an epoch in gas engine construction in this country.

A gas engine of 1,000 horse power cannot at the present time be said to be unusual, as several machines of about this power have been built in America and quite a large number are in use in England and on the Continent. This particular machine, however, is the beginning of what will be the largest gas-engine plant in the world and, furthermore, the plant will

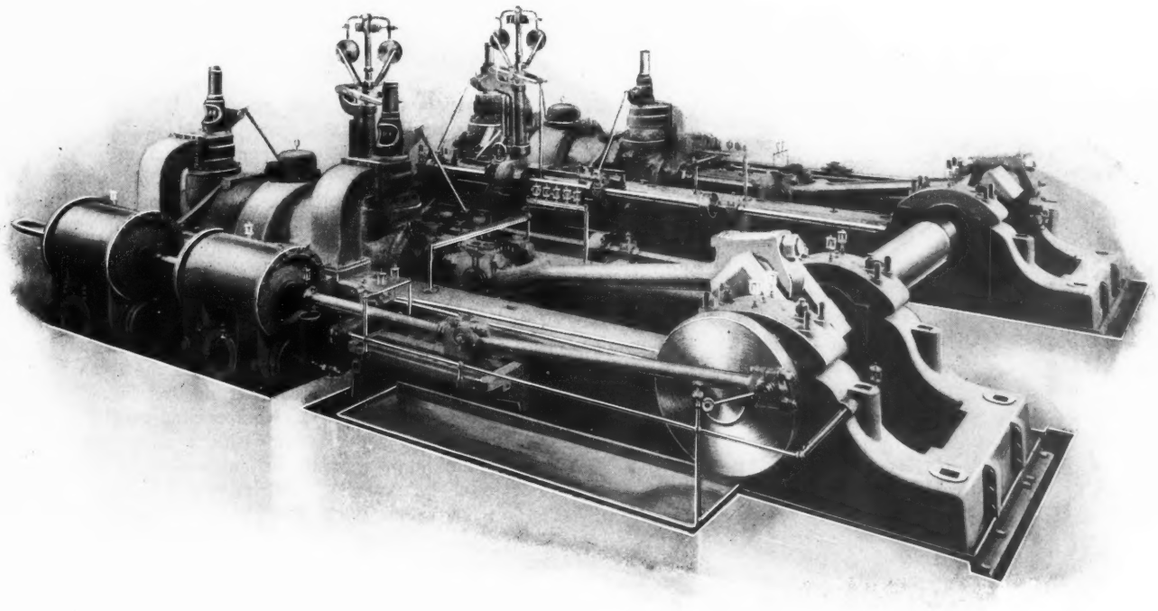


Fig. 1. Koerting Gas Engine of 1000 H. P., built by the De La Vergne Refrigerating Machine Co., New York, for the Lackawanna Steel Co., Buffalo. There will be eight Engines of this size and sixteen of 2000 H. P. each, all Operated by Blast Furnace Gas.

be operated by the waste gases from the blast furnaces of the steel company instead of by producer gas or natural gas, as has heretofore been the case in this country. We are informed that the Pennsylvania Steel Co. are also installing a blast furnace gas-engine plant, so the movement toward larger gas engines, operated by blast-furnace gas, appears to be well established.

The Lackawanna Steel Plant.

The plant of the Lackawanna Steel Company, where the Koerting engines are being installed, will be the largest individual steel plant in the country, if carried out as now projected. The Lackawanna Steel Company was formerly of Scranton, Pa. It was decided to move to Buffalo, however, and something over a year ago work was begun at the new location. The site occupied is on Lake Erie, south of Buffalo, near what is known as Stony Point, and covers an area about 3½ miles long by 1¼ miles wide. The plant will include blast furnaces, Bessemer and open hearth furnaces and a large number of coke ovens, and will be in active operation within three or four months. Some work is already being accomplished while the building operations are in progress. A large machine shop, 500 feet long, has been running several months and work is being pushed on large rolling mill engines for the Lackawanna plant, which were designed by the engineers of the company and are intended to be heavier than any similar engines ever built. Not the least in importance in the great undertaking is a ship canal, extending three-fourths of a mile into the property from the lake shore. It will be 200 feet wide, 25 feet deep, and will be served by ore handlers which will transfer the ore from the holds of vessels in the canal to the storage yard near by. The most impressive sight, however, to one mechanically inclined, is the two large power plants in which are to be located the gas and steam engines for electric generating, for furnishing the blast for the blast furnaces, and other miscellaneous purposes. The larger of the two power houses is 700 feet long and will contain, besides several large steam engines and air compressors, eight 1,000 H. P. Koerting gas engines, direct-connected to two 500 K. W. generators. The first gas engine was erected and started in the latter part of November and ran satisfactorily. It was first tested by compressed air and is now being run by a temporary gas producer plant, pending the completion of the blast furnaces. The other power plant will contain sixteen 2,000 horse power Koerting gas engines, of the same type as the one shown on this page, but will be used for operating blowing cylinders mounted on vertical frames directly over the cranks of the engine. These cylinders are being constructed by the Southwark Foundry and Machine Company, Philadelphia, and the proportions of the machines can be judged by the fact that the total height above foundations will be 31 feet.

The Koerting Gas Engine.

The Koerting engine is a German machine, designed by Ernst Koerting, which operates on the two-cycle plan and is also double-acting. This gives an impulse at every stroke just as in every steam engine. Nearly all successful gas engines have heretofore been of the Otto four-cycle type and single-acting, with an impulse at every fourth stroke. Apart from its connection with the immense power plant of the Lackawanna Steel Co., therefore, and its operation by blast furnace gas, the machine has certain constructive features that will well repay careful study on the part of the student and of the engineer.

In the two cuts herewith will be found sectional views of the Koerting engine, one being a plan view and the other a cross-section taken in elevation. As stated above, the engine is double-acting like a steam engine, hence the crank end and the head end of the power cylinder are similar. The admission valves are located in the valve boxes, which are bolted to the cylinder heads, and no exhaust valves are required, as the products of combustion escape through slots or ports cast in the middle of the cylinder from where the exhaust pipe leads. These slots are covered by the motor piston itself. For this purpose the piston is made very long and is packed at each end by the customary self-closing spring rings.

The combustible mixture is admitted through two double-acting auxiliary pumps, the one for gas, the other for air. These pumps are so proportioned that their combined action always secures the proper mixture necessary for complete combustion and introduces the same to the working cylinder. The compression spaces of the pumps are divided, so that the crank ends of the air pump and gas pump discharge into the crank end of the power cylinder, and the head ends of the pumps discharge into the head end of the power cylinder. The gas and air are compressed by the pumps to about nine pounds per square inch.

Referring to Fig. 2, it will be seen that the piston is at the outer dead point, and that the exhaust ports are exposed toward the opposite or head end of the engine. The instant

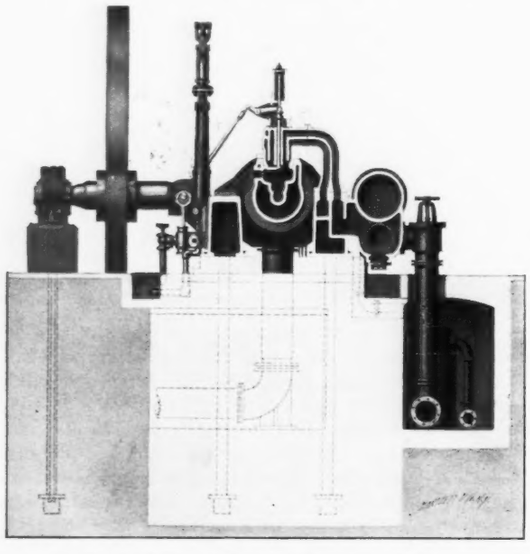


Fig. 3. Sectional Elevation of Koerting Engine.

the piston begins to uncover the exhaust ports, the pressure of the residual products of combustion in the cylinder drops rapidly to that of the atmosphere; when this has taken place, the inlet valve is opened and a fresh charge admitted by the pumps. The valve gear of these is so designed that air only is supplied first, to separate the burnt gases from the succeeding mixture, and afterward gas and air, mixed in proper proportions.

The combustible mixture of gas and air is produced only at the inlet of the cylinder. There is no storing of it, and by suitable construction of the admission device, mingling of the air first introduced with the burnt residue gases, or with the succeeding charge of the combustible mixture, is adequately avoided. For the same reason, loss of mixture through the exhaust ports, which are open during this period, is prevented.

Shortly after the exhaust ports are again covered by the

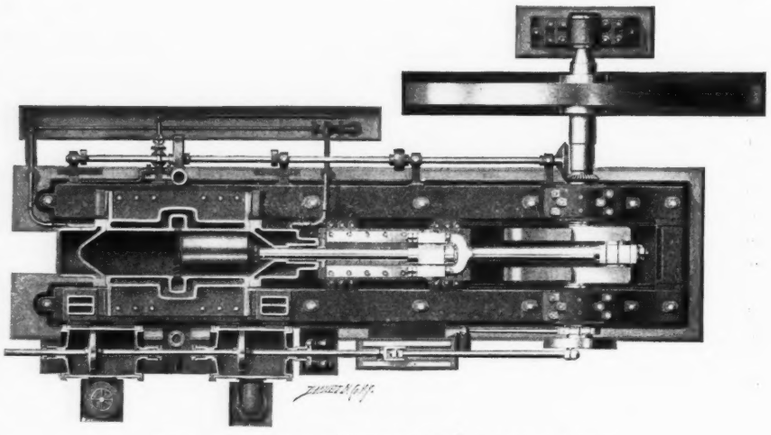


Fig. 2. Plan View of Koerting Gas Engine, taken in Section.

receding piston, the air and gas pump pistons arrive also at their dead point position, and the supply of mixture is interrupted. The inlet valve closes and the charge is compressed in the cylinder in the usual method, till, at the dead point of the stroke, ignition takes place.

At the next movement of the main piston, the ignited charge exerts its driving power by expanding till just before arriving at the other dead points, when the piston uncovers the exhaust ports again and allows the consumed charge to be blown out. On the opposite end of the piston the same operation takes place. This arrangement necessitates the double passages between the small cylinders and the large one, as shown in the two sectional views.

In order to secure the separating layer of air above referred to, between the hot consumed gases and the fresh charge, the gas pump is so constructed that no gas is delivered until after a certain point in its compression stroke. The pump is provided with piston valves with the valve gear so arranged that its maximum capacity cannot exceed 50 to 60 per cent. of its total displacement. For after the pump has completed the suction stroke, the gas suction port is left open during a portion of the succeeding (compression) stroke, so that the gas can return without increase in pressure until the suction port is closed, when the gas is compressed and passed out through the compression port.

The amount of gas thus furnished corresponds to the maximum power of the engine.

Regulation of the power is effected as follows: When the load on the engine is reduced, the gas pump begins to furnish gas at a correspondingly later period, thus discharging a diminished quantity of gas into the working cylinder. This is accomplished either by the valve gear of the pump, and controlled by the governor, or by a by-pass located between each pump end and respective compression channel which leads to the inlet valve on the main cylinder. The throttling device in this by-pass is also under the control of the governor.

It is evident from the above that the engine operates with a variable amount of mixture, and that correspondingly more or less air is sent first into the power cylinder. This air stays near the middle of the cylinder, while the combustible mixture remains at the heads of the cylinder near the inlet valves and igniters. The peculiar shape of the cylinder heads prevents mingling of the layer of air with the following mixture of gas and air.

For ignition there are provided two spark coils at each end of the power cylinder. These are operated by a separate shaft, driven by spur gearing from the cam shaft. The gear

on the igniter shaft is not fast; it is connected with a sleeve having a feather, which is set spirally around the shaft so that by a sliding movement of the wheel the igniter shaft may be set behind or in advance of the cam shaft. Thus the time of ignition can be changed during running of the engine to suit whatever kind of gas is being used. A further advantage secured by this arrangement is, that at starting, the point of ignition may be so set that ignition takes place only after the piston has passed the dead point, and the engine started very slowly without incurring any pre-ignition. Very lean gases require much earlier ignition than is otherwise usual. In practice, indicator cards are taken from time to time to check the timing of the ignition, and to see whether the combustion of the gases is without fault. Igniting of very poor gas mixtures presents no difficulties at all with this arrangement. The engine is started with compressed air. Engines to which a blowing cylinder is attached are easily started with air under 150 pounds pressure; for those without such cylinders 90 to 120 pounds per square inch is sufficient.

A piston valve is provided for admitting the compressed air at front and back ends of the cylinder, as in a slide-valve steam engine. This piston valve is operated from the cam shaft by an eccentric, which can be thrown in or out of gear like a clutch. Filling the cylinder with air twice is generally sufficient for starting up, after which the engine runs itself.

The power cylinder and piston are cooled by circulating water, which in the case of the piston enters the tube carried through the crosshead pin and hollow piston rod, and returns the same way, but on the outside of the tube. The stuffing boxes in the cylinder heads are surrounded by water. The cylinder walls also are cooled throughout, except at the middle where the exhaust slots are. By maintaining the piston cooler than the cylinder, the expansion of the former is under entire control and the result is good running of the engine.

The Development of the Gas Engine.

It will be interesting to note in this connection that gas engines were not considered of any importance in this country, or anywhere else for that matter, previous to the Centennial in 1876. At that time the Otto "silent engine" attracted considerable attention and for several years until the patents expired this make of engine was the only one in evidence. Later, many other firms started in the gas engine business but the machines which they built were all of small sizes and all operated on the Otto cycle. For the most part gas engines have been used where only a small amount of power was required and have been run with illuminating gas, thus making a very convenient motor and one which could be located almost anywhere. With suitable modifications they have been adapted to use with gasoline vapor or with natural gas. It was not until 1897 or 1898 that large gas engines began to be built in this country—one of 650 horse power being completed by the Westinghouse Machine Co. in 1899. In fact, it was generally considered that while a small gas engine was a convenient and economical motor, large gas engines would meet with almost unsurmountable difficulties and might never become important competitors of the steam engine.

It is obvious that when operating on the Otto or four-cycle plan, with an impulse at every fourth stroke, an engine of 1,000—or even of several hundred horse power—would require a cylinder of enormous size and other parts in proportion. If operated with illuminating or natural gas, it would involve the handling of large volumes of a highly inflammable gas and there would be occasional violent explosions, which would be positively dangerous. These two facts, drawn from experience with small engines, probably had their influence in delaying the construction of large machines. As has frequently been the case, however, English and other European engineers were ahead of us. They got around the difficulty of the large cylinder by using two cylinders in tandem or two engines in pairs, and by the perfection of the two-cycle type like the Koerting. They also successfully introduced producer gas, which is less inflammable than illuminating or natural gas. Even producer gas in the proportions in which it was first made would not have been successful for large engines because it contained a considerable proportion of hydrogen, which ignites and combines very readily with the oxygen of the air at comparatively low temperatures.

One of the earliest advocates of producer gas was Mr. J. Emerson Dowson, who called attention to its possibility in the *Journal of the Society of Arts*, in 1882.

In 1894 the idea of utilizing blast furnace gases was suggested by Mr. B. H. Thwaite, in England, who showed that its elements and the proportions in which they existed were about the same as with producer gas, and who built a 20 horse power experimental engine to demonstrate the feasibility of the plan. While gas engines will now undoubtedly be used more and more in connection with blast furnaces there is still the objection that blast furnace gas is heavily loaded with dust which will cut the cylinders unless the gas is thoroughly cleansed, and the constituents of the gas are such that it is not easily ignited in the engine cylinder.

Using Blast Furnace Gas.

The usual blast furnace plant contains, in addition to the blast furnace, two blowing engines for producing the blast, three brick stoves (four are used at Buffalo) for heating the blast on the regenerative principle and several boilers for generating steam for the blowing engines. The waste gases from the blast furnace are alternately burned in one or two of the stoves, while the blast is forced through the remaining one or two, previously heated. The process is one of alternately heating and cooling. The waste gases are also burned in the furnaces under the boilers, which latter are generally of simple construction, and not economical in operation, since there is always more gas produced than can be utilized in connection with the stoves and blowing engines. When it comes to using the waste gases in internal combustion engines, a horse power can be produced with one-quarter to one-sixth the quantity of gas consumed per horse power under the boilers in the usual manner, and it is possible to derive enough power to light the works and operate much of the machinery about the plant. This fact being realized, and the large gas engine having proven a success, a new era in power development will be the result.

When the gas leaves a blast furnace it is at a temperature of from 700 to 1,000 degrees, is charged with more or less steam and, as before stated, is laden with dust. Before being suitable for use in a gas engine cylinder the dust must be removed by a scrubbing process, such as passing out through a tank containing coke, through which water runs, or by spraying water on the blades of the fan usually employed to draw the gas through the pipes from the blast furnace and deliver it to the engine cylinders. The gas is also cooled to condense the steam and allow it to separate from the gas, leaving the latter drier and more suitable to use.

The calorific capacity of blast furnace gas is low, as shown by the comparative figures given below:

	British Thermal Units per cu. ft.
Natural Gas	1000
Illuminating Gas	650
Water Gas	450
Producer Gas	125
Blast Furnace Gas	100

While an engine must be larger if it is to be operated by blast furnace gas than if used with a more efficient fuel, its size need not be as great as indicated by the number of heat units, since a much larger charge can be used than with natural or illuminating gases, which are more inflammable.

* * *

The *Electrical World and Engineer* says that a 60,000-volt power transmission line 105 miles long is projected at Guanajuato, Mexico. Power is to be transmitted from a waterfall by the tri-phase alternating system and the line wires are to be supported on steel towers 440 feet apart, making 12 to the mile. The line wire is a cable made up of 19 strands of copper wire having an aggregate section equal to a No. 1 solid wire. The reason for using a cable instead of solid wire is that the tensile strength is increased fully 50 per cent. over the solid wire, and high tensile strength is quite necessary with such long spans. It is estimated that the cost for the tower-supported line will be no more than for a pole line.

SHOP CONSTRUCTION.—4.

FOUNDATIONS.

OSCAR E. PERRIGO.

It is but quoting an old maxim to say that if we are to build a good house we must have a good foundation to build it on. And we may just as pertinently say that if we are to build a good and substantial foundation, we must have something solid to lay it upon. Otherwise we shall be like the man who built his house upon the sands. The diversity of the ground, at the surface and down through the stratifications of material of various densities and strengths, from the solid nature of rock to the almost fluid condition of alluvial soil, must be considered. Each of these conditions requires special treatment according to its nature.

To properly secure a firm bed for the foundation of a building, we must either excavate down to firm and solid ground, technically called "hard pan," or we must by artificial means produce a substantial surface upon which to begin the masonry. It is quite impossible for the architect, the mason or the contracting builder to tell us by a superficial examination of the ground how deep we must go to reach solid ground, or "hard pan." To some extent this may be ascertained by "sounding;" that is, by making small excavations at various points, to obtain the necessary information upon which to determine not only the depth to which the foundation must extend, but whether the nature of the ground renders such artificial support as piles necessary.

It may be found that at some points in the foundation of extensive buildings we need excavate only a few feet, while at others, very deeply; and still at other points the ground may be of such a yielding nature that piles must be driven. Or we may find that the use of piles would be a much more economical method than very deep masonry. But whatever the depth we may be obliged to go to, or the process by which we produce our bed for the foundation, all parts of it must be, not only firm and practically unyielding but level. Hence, when we excavate to varying depths the earth must be "benched out," as it is called, as shown in Fig. 5.

Great care should be taken to have all parts of the bottom of the excavation of as equal density and resisting power as possible, that they may equally support the great weight of the wall to be built. This condition becomes all the more important as the walls of the building are higher and the consequent weights and strains correspondingly increased. It is, of course, true that no ground can be found so absolutely solid as not to yield somewhat when the weight of the building is put upon it, and therefore we must not expect to wholly prevent a certain amount of settling; but we should use all possible care to have this settling as equal as possible over the whole area of the foundation.

Having ascertained the nature of the ground as far as possible, we may determine the kind or kinds of foundation necessary. If the ground is so soft and yielding that excavation to solid earth will have to be very deep, making a stone foundation excessively expensive, piles should be driven as deep down as possible—say, two feet apart, from center to center—and cut off level at the top, and be down low enough to remain always wet. Upon these piles timbers of sufficient size are placed, being laid across each row of piles; then upon these another course of timbers, at right angles to the first. These may be laid close together or two or three inches apart, the size of the timbers being determined by the weight of the wall they are to support. For instance, for the walls of the machine shop proposed in these articles, the timbers may be 10x12 inches laid on edge. Fig. 1 gives a plan view of this method and Fig. 2 shows a cross section of the same. It is not always necessary to arrange the piles in three lines, with those in the center row in line with those of the two outer rows, as shown. Where the weight of the superstructure is not excessive it is often preferable to begin by setting three piles in a row, then two so they will come opposite the intervals of the first row; then, the next row of three in line with the first; then another row of two piles and so on. Where there is considerable depth from the top of the piles without side support it is necessary to drive "sheet piling." Set planks three inches thick, or thicker, with their edges close together so as to enclose the work on both sides, and afterward fill in the spaces between these planks and the solid earth with tightly rammed gravel, and if necessary fill the spaces between the piles with stones or concrete. This will give them quite sufficient support to make a very firm foundation bed and prevent any lateral movement which might result from the bending of the piles.

Timber should not be used under a foundation unless it is in a position to be kept continuously wet by the surrounding soil, for the reason that if always wet enough to exclude the air it will endure for a very long time, but if so situated as to be sometimes wet and again dry, it will soon decay. Therefore, if the use of timber, as above described, is not feasible we must use stone and so arrange the piles, regarding the distances from center to center, as to allow the use of such stones as are available, cutting off the tops of the piles below the water line if possible, or at least so low as to have them always wet. This arrangement is shown in Fig. 3.

Sometimes fairly solid earth may be reached within a reasonable depth, but it requires digging quite a depth beyond this before reaching really solid ground or "hard pan." In such a case it may be advisable to lay down first, a course of concrete four to six inches thick, then a layer of timber and another course of concrete, which will furnish an excellent bed for the foundation. The second course of timber may be replaced by a course of 3-inch planks if the wall is not a very heavy one. Circumstances might also warrant three courses of timber. The width of the timber work should be from two to three times the thickness of the wall. Fig. 4 shows such an arrangement.

A prominent public building has stood for many years on very soft and yielding alluvial soil, upon which such a foundation as that described above was laid over the entire area to be covered by the structure, and many feet deep. Then the stone foundation proper was built upon it, after which the very heavy and massive stone building was erected.

Where excavations vary in depth at different points of the same wall the ground should be cut out in steps, or "benches," so that the bed whereon the foundation is built may be perfectly level. The lower steps should be built in with as large stones as possible and brought up to the level of the more shallow parts. For the larger stones require a smaller number of cement joints and will settle less and consequently, are less liable to disturb the work by yielding unequally. See Fig. 5. In all cases the excavation should be made below the reach of frost.

In building up a foundation of stones they should be laid with as near horizontal joints as possible so as to prevent the lateral movement of the stones by the weight put upon them. They should also be laid as far as possible in courses, and each course leveled off before commencing the next, the thickness of the courses necessarily depending on the thickness of the largest stones. These points are all the more important at corners, where tendencies to disintegrate are the most liable. The foundation is laid considerably wider at the base than at the top, either in a wall gradually decreasing in thickness (that is, technically, with a "batter" of so much per foot, as in Fig. 6) or more commonly by a wide footing of one or more courses of larger stones. Above that it is built with regular vertical faces as shown in Fig. 7.

However the foundation wall may be built, the space between it and the sides of the excavation should be filled in, either by tightly rammed earth or gravel, or better still by "puddling," that is, by flooding the space with water, throwing in the earth or gravel and allowing it to settle, ramming only from six inches to a foot of the top. The foundation of stone should be carried up above the level of the ground, from one to two feet according to circumstances. If the main floor of a building is to be raised several feet above

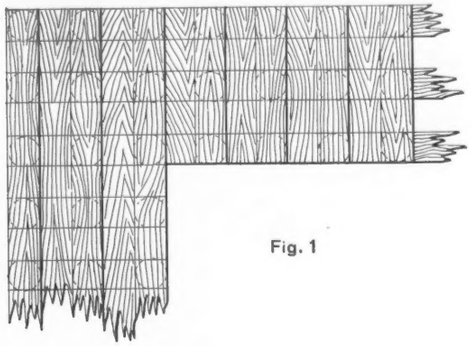


Fig. 1

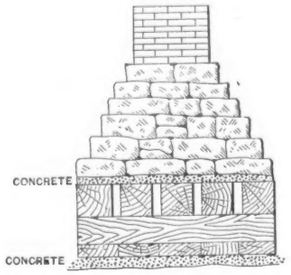
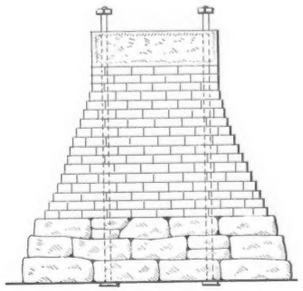


Fig. 4



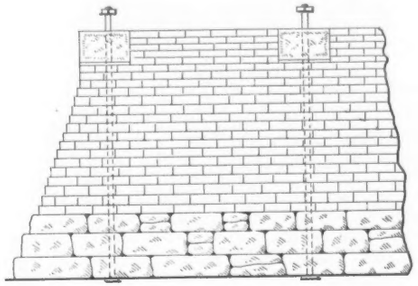


Fig. 8

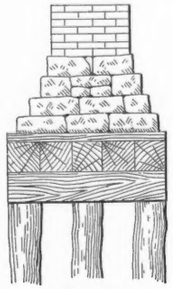


Fig. 2

Fig. 3

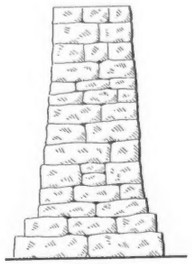


Fig 6

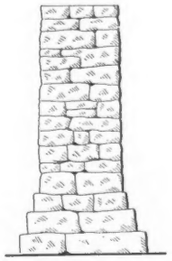


Fig. 7

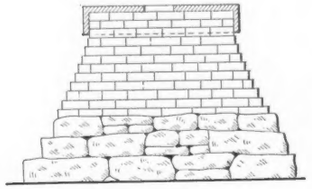


Fig 9

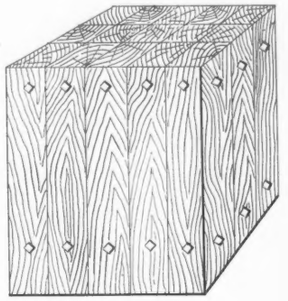


Fig. 11

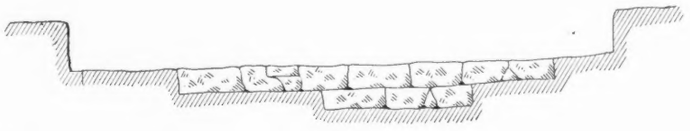


Fig. 5

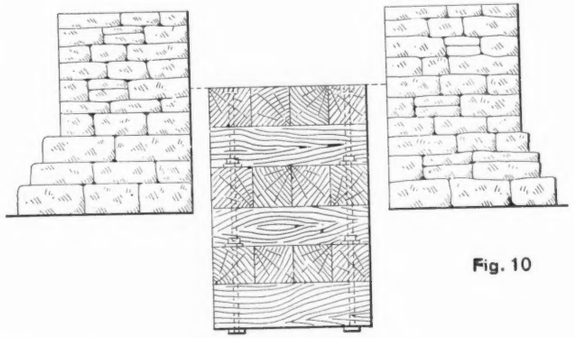
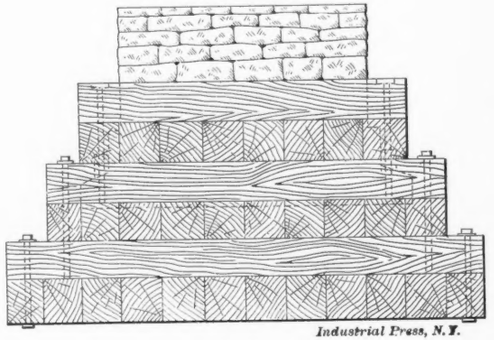


Fig. 10



Industrial Press, N.Y.

Sketches Illustrating the Subject of Foundations for Manufacturing Plants.

the ground level, it is usual to build the foundation high enough to rest the floor timbers upon it, filling in the spaces between them with brick and leveling up ready for the brick wall.

The importance of using strong mortar in foundation work seems to demand that particular attention be paid to the proportions of its ingredients which will make the best compound of its kind. Use two parts of Portland cement, one part of slaked lime, and about three parts of clean, sharp sand. The quantity of sand must be varied according to its fineness, sharpness, and freedom from dirt. A larger quantity of fine sand will be needed than of coarse. Some sand has a more rounded grain instead of the sharp angles of the better quality. Of such sand more must also be used.

Foundations are generally laid in mortar having a greater or lesser proportion of cement. They should also be stronger in this respect for the lower or underground courses than for the upper ones so as to better resist the action of water. In fact much of a foundation is frequently laid in mortar composed of only cement and sand, omitting lime altogether.

Thus far only the foundations for buildings have been considered. These have for their principal object to sustain the weights of the superstructure erected upon them. In the case of the foundations for machinery it is quite different. Here not only the weight must be sustained but the question is complicated by the jars, strains and shocks due to the operation of the machines; and this must also be considered. These vary largely in different cases, as for instance, the steady revolutions of a large lathe, the reciprocating motion of an engine and the vertical concussions of the steam hammer or drop press. Foundations for engines, large lathes, planers, boring mills and so on, are built in a manner somewhat similar to that for the foundation of a building, except that they are usually much broader at the base, conforming in a general way to that shown in Fig. 8. Only a good quality of hard bricks should be used, and the entire work should be laid in strong cement mortar.

The holding-down bolts, when it is necessary to use such fastenings, are made long enough to reach well down in the foundation, if not entirely through it, and are provided with large washers or plates at their lower ends. These are put in place as the foundation is built up and their top ends are held in position by a templet made of boards in the form of a frame, and representing the base of the machine. In a large foundation of this character, blocks of dressed stone should be worked into the finishing courses of bricks so as to bring them level with the top. These are usually placed crosswise, one at each end; and others at such points as to furnish firm support for the cylinder, crank shaft, pillow block, and guides of an engine; for the headstock of a lathe, and for suitable points along the length of the bed; under the uprights or housings of planers and at each pair of legs, or at proper intervals where the entire bed rests on foundations without the use of legs. Usually, in the case of a planer, and often of a large lathe, the foundation is composed of a series of piers built up separately at the points to be supported, each pier being capped by a stone of sufficient size to cover it.

In laying out the foundation for a planer of say, 36x36 inches or larger, a pit should be provided under the center; that is, from a point one to two feet back of the face of the uprights to a point three to five feet in front of the uprights, and five to six feet deep. It should be broad enough for the building of narrow steps leading down into it. This pit will receive a great portion of the chips produced, and in it, resting on large and firmly set stones, should be two cast-iron columns, with strong jack screws tapped into their tops, and coming up into contact with the under side of the bed at a point near the face of the uprights. Thus arranged, they are very useful in maintaining the proper alignment of the planer. A foundation now in use, upon which large lathes are erected and tested, was built as shown in Fig. 9. Solid ground was found about five feet below the floor level, and a course of concrete was first laid, then three courses of stones, and upon these hard bricks, cement being used throughout. Upon the top of each pier a cast-iron plate 1½ inches thick was placed. This plate had downwardly projecting flanges all around it, deep enough to cover three courses of bricks. In the top of these plates was a hole six inches in diameter. When the brickwork was finished these plates were put in place and leveled up so as to leave about half an inch space between the plate and the top of the bricks. Around the lower edges of the flanges the space was carefully closed with cement. Then cement was mixed thin enough to flow easily, and was poured into the hole at the top until the entire space at the top and sides was completely filled, and the whole was allowed to "set." The tops of the plates were about ¼ inch above the top of the floor, which was built up closely around them. Very heavy lathes are moved on and off these piers almost daily without injury, and the piers have not settled to any appreciable extent, or so as to cause any difficulty in leveling up machines to be tested.

In placing high speed engines or planers, which are liable to lateral shocks, it may be advisable to provide cast-iron plates as described above, with the downwardly projecting flanges to cover the upper courses of brickwork, and also with upwardly projecting flanges enclosing sufficient space for the base, cabinets or legs, as the case may be. After leveling up the machine with steel wedges, say a ¼ to a ½ inch, the space is filled with melted lead or brimstone, which when cool will form a very secure, serviceable and durable arrangement.

Foundations for machines subject to considerable vertical shocks, such as steam hammers, drop presses and the like, must be treated in an entirely different manner. From the nature of the work a solid foundation of stone and brick is not usually considered as best adapted to the conditions. Such a foundation would soon be spoiled by cracks and disintegration from the shocks, and serious consequences to the machine might ensue, the parts broken, for instance, or the dies ruined. For such cases many experienced men prefer foundations that may be elastic enough to relieve the machines somewhat of the sudden strains and shocks of heavy and oft-repeated blows. In these cases the foundations are composed of timbers. There are two common types of these foundations. The first one, for small or medium sizes of drop presses or hammers, are built with timbers set on end and firmly bolted together in sufficient numbers to form a foundation of the required size, as shown in Fig. 11, the bolts going entirely through the mass. Timbers 10 x 10 inches or 12 x 12 inches are a convenient size, and hard pine is found by experience to be best adapted to the work. The excavation is first made to solid ground, then a foot or so of hard gravel is tightly rammed down in the bottom, to form the bed. The timbers are cut of a proper length to reach the surface, but should not be less than five feet long. They are bolted together, lowered into place, and leveled up and good hard gravel is tightly rammed in around the timbers filling the space between them and the sides of the excavation.

This form of foundation is adapted for drop presses and small hammers in which the anvil is a part of the machine itself. In case a hammer is of such size as to have the anvil detached from the main frame, the latter is supported upon a stone foundation, or on one partly of stone and partly of brick (built in two piers for a double hammer), as in Fig. 10. The foundation for the anvil is built of timbers laid horizontally, the base being spread over as large an area as practicable, in order to resist the force of the blows of the hammer. In a double hammer the anvil foundation must be restricted in width, but may be extended in length at the base so as to present the form shown in the engraving.

The size of the foundation is necessarily proportioned to the size of the hammer, but approximately as follows: Supposing the width between the upright parts of the main frame to be six feet, the width of the timber work will be about four feet, the length on top eight feet and at the base twelve feet—assuming the necessary depth to be four feet. If solid ground is not found at this depth, the excavation may be filled up with hard gravel, stone or concrete; or a layer of concrete may be placed at the bottom, then a course or two of stone laid in cement mortar, and finally hard gravel well rammed in. The timbers should be bolted together at the

corners or securely spiked, but owing to constant shocks, bolts are to be preferred. The top corners of the timbers should be bolted together horizontally. The masonry piers and timber foundations must not in any way be connected, as the constant concussions would soon disintegrate the masonry. All spaces around the masonry and timber work should be tightly rammed with hard gravel. The size of the timbers may be from 6 x 6 inches and larger according to the size of the structure; but they are usually 10 x 10 inches or 12 x 12 inches. Timbers used in places where decay is feared should be coated with hot gas tar as a preservative.

On one occasion, in soft and very yielding ground, a machine of forty tons weight was supported by a foundation built by excavating nearly 30 feet deep, piles being driven at two feet centers over an area about three times the width and length of the base. Upon these was built a timber structure in the manner described, up to within six feet of the surface of the ground, and gradually drawn in to four feet larger all round than the base of the machine, which was quite high in proportion to its width of base. On this timber work stone laid in cement mortar was built up to the level of the ground and the machine erected upon it. The foundation proved successful.

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NOTES ON CORRESPONDENCE INSTRUCTION.

SOMETHING ABOUT THE WORK OF THE INTERNATIONAL CORRESPONDENCE SCHOOLS, AND OF THE AMERICAN SCHOOL OF CORRESPONDENCE.

The remarkable progress in correspondence instruction during the past few years is the most interesting fact connected with the great educational movement of the present time. It is said there are more correspondence school students in the state of Massachusetts alone than in all the colleges and universities of the whole country. This means that there are thousands of persons, mechanics and others, who do not believe the saying to the effect that a workman is hired to work, not to think. The best mechanics are those who do think, who are well informed, who are well grounded in the foundation principles of their trade; and the same is true, only to a greater degree, as they advance to the higher positions of foreman, superintendent, and so on.

A representative of MACHINERY recently stopped at Scranton, Pa., en route to Chicago, to call at the International Correspondence Schools, and later, when in Chicago, a visit was paid to the American School of Correspondence in their new quarters adjoining Armour Institute. As many readers are personally interested in correspondence instruction it is believed that a brief report from these two institutions will be welcome.

It is generally known, of course, that the International Correspondence Schools are conducting their work on a large scale, but it is doubtful if many appreciate the enormous proportions to which the schools have grown during the few years they have been established. There is now an enrollment of nearly 500,000 students, or nearly half a million, with a rate of increase of about 13,000 students per month. There are 1,200 employees of the schools in Scranton alone. In 1898 a large executive building, of stone and four stories high, was erected for office purposes, also a printing office with accommodations for 200 workmen. But here, as in other departments, the growth has been so rapid as to exceed all anticipations and the buildings were no sooner completed than they were found inadequate, and at the present time additional rooms are rented in every available office building in the city. In the matter of printing, conditions are even more inconvenient. All the new text books are printed in New York City, and all the printing offices of Scranton are assisting in printing the circulars, blanks, etc., used by the schools.

The outcome of the whole matter is that still another new building is being erected for both office and printing purposes, which it is hoped will meet the requirements of the concern, for a time at least, and to provide for the future it is so planned that it can be enlarged to twice its present size. The building will be 460 feet long, 167 feet wide, divided into three bays—one at each end three stories high, and a middle bay 300 feet long, partly one and partly two stories high, where will be installed the printing offices and machinery. Mr. T. J. Foster, the founder of these schools, is taking much pride in having the new building a model of architecture in every respect, that may be held up to the students as an example for their guidance. It is being constructed of Pompeiian brick, both inside and out; the machinery will be motor driven, the elevators of the plunger type, and the power plant will be of the most approved type in every respect, with reserve units for emergency use. This building is perhaps the most interesting feature to report upon at present.

There have, however, been several changes and additions in the courses of instruction and an extensive revision of the papers of all the courses is in progress, including the course in machine shop work to which we have referred in a previous number of the paper. One secret of the rapid increase in the business of the schools is that new courses have been frequently added, taking up different departments of work, and adapting correspondence instruction to new fields where there appeared to be a demand for instruction. There are now 142 different courses, and they include such unusual subjects as the packing house industries, the manufacture of leather and of soap, window dressing, metallurgy of gold, silver and copper, etc., these being mentioned to show the diversity of instruction. Two new departments have been established, the School of Navigation and the School of Textiles, the latter acquired through the purchase of the Correspondence School of Textiles of Bedford, Mass. In preparing the various instruction papers outside writers are employed, if the time of the instructors at Scranton does not permit, or the experience of those intimately connected with commercial work is desired.

There is now being issued, in a library of about 50 volumes, a collection of the best instruction papers upon various technological subjects. As a matter of course the subjects of the various courses overlap to a greater or less extent and it is believed that many would like a reference library, written in elementary style, which treats of the different technical subjects, but without duplication. This library will be added to until it contains upwards of 75 volumes. In preparing these, special attention is given to the illustrations, as will be appreciated by those who have seen the International Correspondence School papers, which are probably the best illustrated of any technical books at the present time, not excepting books by our best publishers.

The American School of Correspondence.

The American School of Correspondence at Chicago, recently removed from Boston, is pleasantly located in buildings adjoining Armour Institute of Technology and owned by the Armour interests. The offices are novel in that they occupy what were formerly apartments, or flats, two whole apartment buildings having been secured for the purpose. They make an almost ideal arrangement, however, for so diversified a business as correspondence instruction, where there are many departments and private offices are needed by the various instructors.

As most of our readers are probably aware, this school is trying a new and important experiment in correspondence instruction. The removal from Boston to Chicago was because of arrangements by which the correspondence method of the American School of Correspondence is to supplement the work of Armour Institute; or more properly, perhaps, is to be supplemented by the work of the institute, in so far as students of the correspondence courses are able, through their preparation, to profit by the superior advantages of a residence course at Armour Institute. It is proposed that a student shall have the opportunity of enrolling in the school of correspondence with the idea of eventually completing his studies as a regular student at Armour Institute.

The arrangement by which the two schools are to cooperate in offering instruction has been in effect for so short a time that it is impossible to estimate at present to how great an extent the correspondence studies may be made of service to prospective Armour Institute students. Before the full benefit of the arrangement can be secured some of the papers

of the correspondence course must be rewritten to conform to the instruction given at the institute, and this work will be under the supervision of the Armour Institute faculty. It must be remembered that as the correspondence courses now stand they are intended to give elementary instruction of a more or less superficial character, adapted to the needs of the workman with limited education. They were prepared from an entirely different standpoint from the courses of a technical college.

There are three different departments or grades of study under the direction of the Armour Institute. First and most important is the School of Engineering, corresponding to the best technical colleges, which give a degree upon the satisfactory completion of four years of study; second, is the Academy, of high-school grade, which equips students to enter the school of engineering; and lastly the Armour Institute evening school.

It is not expected that a course of correspondence will enable a student to cancel any of the studies in the school of engineering, as it is desired for the present, at least, that a person shall spend four school years at Chicago, before receiving his degree, so that he may come into intimate contact with the instructors and derive the full benefit of the laboratory instruction. What will be accomplished, however, and is now to a considerable extent, is to apply as much of the correspondence instruction as possible to prepare a student to enter the school of engineering without taking the course in the academy. It is believed that a person will be able to fully qualify to enter the institute in this way, and at the same time his correspondence studies will make his residence course easier for him and possibly enable him to take other additional studies that he could not otherwise complete. A course in correspondence will also enable a student to cancel certain studies given in the evening school.

The papers that are now being prepared for the correspondence schools are being written by outside authorities, for the most part, or by Armour Institute instructors, and the custom is adopted of putting the author's name on each paper. This experiment in technical instruction is similar to what is being done with success by the University of Chicago in general studies, and it will be carried along on conservative lines and, we believe, strictly on a high plane.

* * *

INTERNALLY AND EXTERNALLY FIRED BOILERS.

The art of steam making is one that has probably received as much attention from inventors and engineers as any other, yet there seems to be a general misunderstanding, on the part of many practical men, of the laws that govern combustion and the best way to absorb the heat from a fire into the water of a steam boiler. The common and mistaken idea is that the water-backed surfaces should be as close to the fire as possible and preferably that they should surround the firebox on all sides. This is a mistake. Economical steam-making requires that: 1. The fuel be burned at the hottest possible temperature. 2. That the heat of the fire be absorbed by water-backed surfaces after combustion is practically complete. To burn the fuel at the hottest temperature the fire must be removed from refrigerating effect; that is, it must not come in contact with water-backed surfaces until combustion is complete.

In a circular of internally-fired boilers recently received, some strong claims are advanced for this type which occasion these remarks. The internally-fired boiler is claimed to be superior to the externally-fired type requiring a brick setting because as the fire is surrounded on all sides by water-backed surfaces, there cannot be so much loss of heat as with a brick setting. The externally-fired boiler is referred to as being a modification of the camp kettle with the addition of a masonry setting which absorbs and radiates much heat, etc. No one can deny that the internally-fired boiler has many good points nor that it is indispensable for marine, locomotive, portable or similar service where brick settings would be impracticable, but the fact remains that the internally-fired boiler must work under conditions that do not favor perfect combustion. The water-backed surfaces surrounding the firebox reduce the firebox temperature and the gases escape into the flues only partially consumed. The tubes cool the temperature of the gases still more, so that they finally escape in a partially consumed state—smoke.

The ideal boiler setting is one in which the fuel is burned in an isolated furnace constructed of firebrick and properly protected to prevent radiation. From this sort of firebox the hot gases are conducted against the water-backed surfaces of the boiler to give up their heat. Firebrick piers may be provided in the path of the hot gases, which become red-hot and tend to maintain an even temperature while the furnace is being fired with fresh fuel. Such a furnace when properly constructed will burn the fuel with little or no smoke and in a most economical manner, but we are not saying that such a construction is always desirable or that it is practical under many circumstances because it is not. It takes up a great deal of room and is expensive. In general, however, these conditions may be very well approximated, in the horizontal tubular boiler with brick setting, by building a firebrick arch over the grate so as to prevent direct radiation of heat to the boiler shell. The objection to this scheme is that it is expensive to build and maintain, and that it increases the total height of the setting. The advantages will probably offset the disadvantages in most cases.

In regard to the character of brick work in a boiler setting it has recently been pointed out by a foreign authority that it is better to have the internal surfaces rough rather than smooth. If the surfaces are smooth the gases have a tendency to travel in parallel lines without intermingling, whereas if the surfaces over which they travel are made rough, the mixing of the gases is favored, and consequently more perfect combustion. The irregular surfaces are obtained by simply laying the bricks so that every alternate brick projects half its length into the furnace. Not only do the projecting bricks break up the stream lines, but they become intensely heated and have a regenerative effect, something after the plan of the Siemens steel furnace.

* * *

GOLD DREDGING IN NEW ZEALAND.

In the November issue allusion was made to a novel gold dredging machine which is in limited use on the Pacific coast. This description having come to the attention of Marshall, Sons & Co., who have large works at Gainsborough, England, they have sent us some interesting literature on the subject of gold dredging, from which we quote in substance:

The gold dredging industry originated on the Clutha River in Otago, New Zealand, about the year 1860. The industry has proved immensely profitable in that province, there being upwards of two hundred dredges at work, many of which are paying monthly dividends of 5 per cent., and more. The spoon dredge was the first type of machine used, but this has been generally superseded by the traveling bucket dredge having one central bucket ladder. The bucket ladder is mounted in an inclined position near the center of the dredge, with the lower end, of course, reaching to the river bed from which the traveling buckets convey the mud and sand. The dredges are built self-contained so that the engine, boiler and separation apparatus are all on board. A traveling conveyor carries the refuse to a spoil bank. The buckets usually deliver into a shoot leading to a revolving perforated screen which separates the stones from the fine stuff carrying the gold. The gold-saving tables are efficient and little gold escapes. An example is mentioned where one hundred particles of fine gold were separated and found to weigh less than one-tenth of a grain. The efficiency of the dredging apparatus is so high and the cost of operation so low that it is said to be profitable to work deposits carrying only one grain in weight per cubic yard. Gold dredging machines are profitably worked in the beds of ancient rivers, even if little water is available. Where no water is at hand, it is carried to the scene of operation in pipes. As the water is used over and over again, the volume of water required is not great, after enough is once obtained to float the dredge. A gold dredger is capable of cutting its way into the bank of a river, and this is often done where the river has changed its course. In such cases the river is left behind, sufficient water seeping through the tailings to float the dredge.

A LARGE HOISTING DRUM.

BUILT BY THE NORDBERG MFG. CO.—THE LATHE IN WHICH IT WAS TURNED.

The striking illustrations in this connection are from the works of the Nordberg Mfg. Co., Milwaukee, Wis., builders of steam engines, hoisting machinery, steam stamps, air compressors, and a general line of mining machinery. The Nordberg Mfg. Co. are now occupying their extensive new plant near the city line of Milwaukee, on the Chicago, Milwaukee and St. Paul Railway, and are unusually well equipped in every way for building the varied line of heavy tools for which they are well known. The plant is the result of much careful thought and study and there are numerous features of interest connected with its arrangement and equipment, and with the engineering work in progress, which we intend to refer to in a subsequent number.

At the present time the most important work on hand is a hoisting engine for the Tamarack Mining Co., Calumet, Mich. In its main features and dimensions this will be practically a duplicate of an engine built for the same company about four years ago, which was designed to hoist from a depth of 6,000 feet, or 720 feet more than a mile, and at a maximum speed of 5,000 feet, or nearly a mile a minute. The famous Tamarack mine, for which these machines were designed, has the deepest shafts in the world, and the two hoisting engines are the largest of their kind and in points of efficiency, safety and convenience show the result of engineering skill of a high order. In general form, they have a massive triangular bedplate, with the rope drum and its shaft supported in bearings at the upper apex of the triangle. There are four inclined Corliss engines resting on the faces of the bedplate and arranged in pairs, one pair operating on a single crank at one end of the shaft and the other pair operating on a crank at the opposite end.

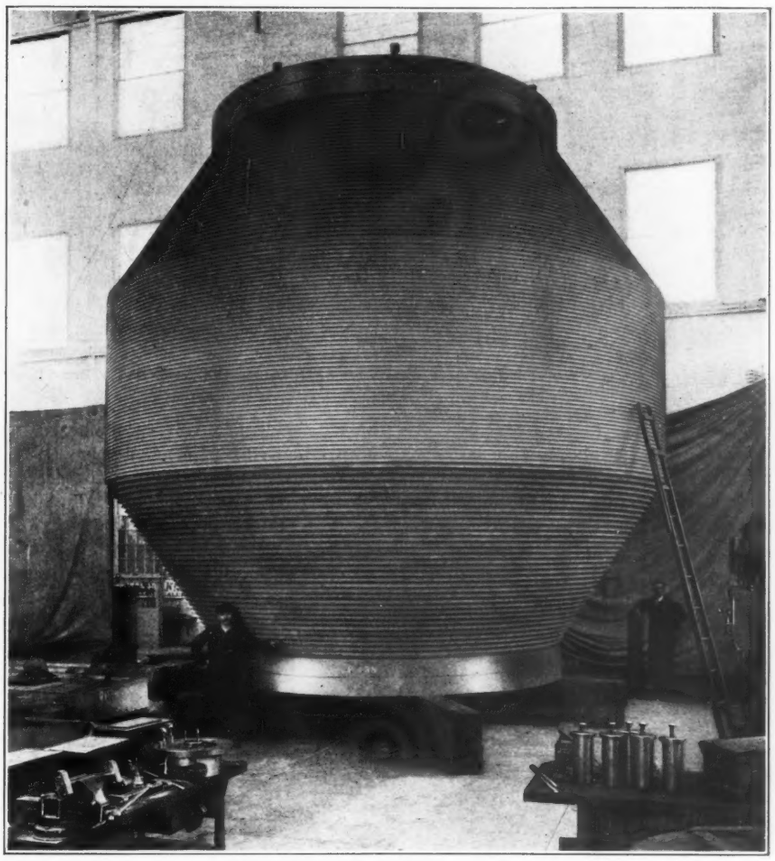


Fig. 1. Rope Drum as it looks Completed. Size, 25 feet Diameter; Length, 24 feet 6 inches. Two 1 1-2 inch Hoisting Ropes, each 6000 feet long, are operated by this Drum.

The rope drum of the first machine had cast grooves for the hoisting rope, but in the machine now building the drum was first turned, to produce a smooth surface like the face of a pulley, and the grooves were then turned out of the solid, making a thoroughly mechanical piece of work. The drum is 25 feet in diameter, 24 feet 6 inches long, and as it stands on end in the shop in the position in which it was photographed for the illustration, Fig. 1, it presents one of the most striking examples of machine work to be found. It is composed of 48 separate segments bolted together, besides the spiders, tension rods, etc., used in supporting it and attaching it to the shaft. The process of turning the grooves on so large a drum is of unusual interest. There are but few boring mills in the country which will take a piece 25 feet in diameter and these are not adapted to turning a spiral groove on the taper ends of a drum. The most feasible plan is to use a pit lathe, and here again much care and patience must be exercised in securing the segmental rings to the faceplate of the lathe in such a way that they may not only be rigid, but may be both turned on their circumferential surfaces and faced on both edges. The various views show how the job was accomplished and are sufficiently novel to warrant careful study.

Figs. 2 and 3 on the next page give an excellent idea of the pit lathe, the former being a side and the latter a front view. One of the conical ends of the drum is in position and the tool is at work grooving it. The lathe was constructed and formerly used at the old plant of the company and when the new works were erected was moved to its present location. It has a massive headstock, placed on a masonry foundation, with a faceplate 15 feet in diameter.

The lathe spindle is hollow, for the accommodation of a large boring bar, so that a pulley or gear may be bored while it is in position on the faceplate. This bar is driven independently of the lathe spindle, by a worm and worm wheel and pulley, to be seen plainly in Fig. 6. The feed mechanism is at the rear of the bar. The lathe spindle is driven by a variable speed motor, on the multiple voltage system. The wire connections and the controller box, together with the motor, appear plainly in Fig. 2. The motor is belted to a pulley at the base of the headstock, near its forward end, and the pulley shaft extends through to the other side of the headstock and drives the faceplate through a train of gears.

There are two carriages and tool blocks provided for the lathe, which slide on ways on top of a heavy cast iron bed shown in Fig. 2. This bed can be moved and clamped solidly in any desired position relative to the lathe. On each side of the pit are long, narrow floorplate castings, anchored to a foundation, which serve as baseplates for supporting the bed. The baseplates have T-slots running lengthwise so that the bed may be clamped in whatever position it is to be located. There are notches cast along the edges of the baseplates and a bar can be inserted in any one of them in order to pry the bed into its position. As it would be somewhat difficult to locate a casting of the size and weight of the slide base with any degree of quickness and precision, especially when turning the taper faces of band pulleys, a taper attachment is fitted to the base and may be employed with either or both carriages. The taper attachment is supported by brackets arranged to slide on ways on the side of the base casting, and it will be noted from Fig. 2 that the attachment proper consists of two long slotted plates, pivoted on the middle bracket, so that the outer ends of either may be moved horizontally

one way or the other as required. When turning the face of a pulley, for example, the middle bracket of the taper attachment would be brought in line with the center of the pulley, and the two cam plates swung inward to conform to the taper of each side of the pulley face. Each tool carriage has three adjustments: one in a longitudinal direction along the top of the bed, and two transverse adjustments, by means of two cross-slides. One of the cross-slides has screw and handwheel adjustment and the other is controlled by a projection attached to the cross-slides, which fits in the slot of the taper attachment, the principle being the same as in an ordinary lathe fitted with a taper attachment.

When doing ordinary turning the longitudinal feed for the tools is accomplished by a ratchet mechanism operated by a gear and pinion back of the main headstock bearing, and clearly visible in Fig. 6. When grooving the drum, a coarse, regular feed is necessary and this is secured by means of a chain drive, appearing in Fig. 2. The chain is driven by a sprocket wheel on the lathe spindle, back of the faceplate. An intermediate overhead countershaft makes it possible to connect up to the sprocket wheel on the carriage slide when the latter is placed at an angle, as in Fig. 2. It also facilitates the use of different sprockets for securing different rates of feed.

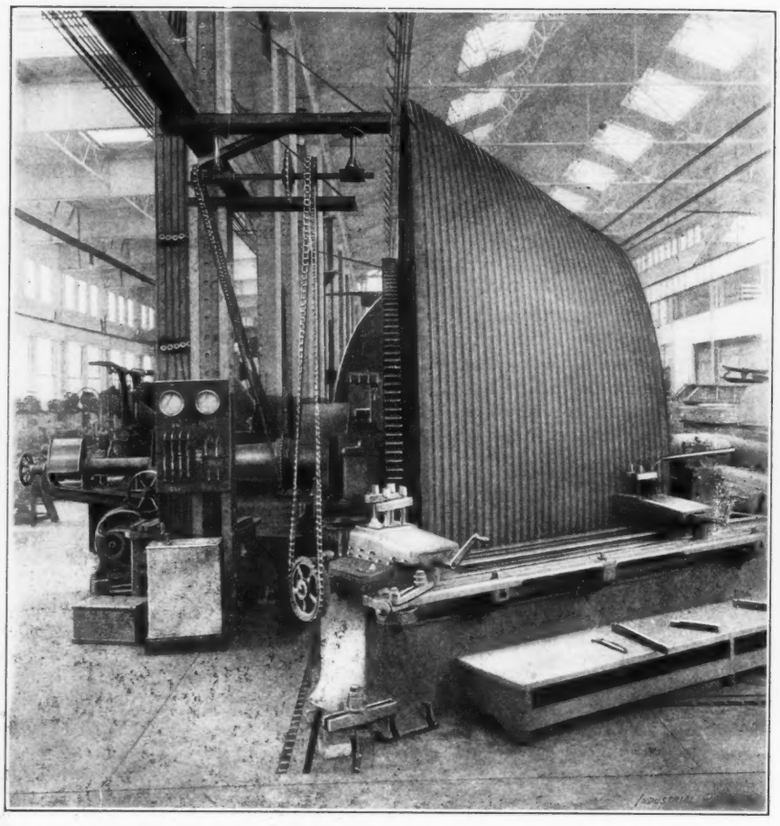


Fig. 2. Side View of Pit Lathe, with Taper End of Drum in position for Grooving.

When work was begun on the large hoisting drum, the lathe was in the old plant and views shown in Figs. 4 and 5 were taken before moving to the new quarters. Fig. 4 shows the lathe at work turning and facing the straight portion of the drum, preparatory to grooving the same, and Fig. 5 shows the grooving operation in process. The straight portion of the drum is built up of two annular rings bolted together side by side and each ring is composed of 12 segments. In Fig. 4 only one ring of segments is in the lathe, the parts of the other ring being piled up at the further side of the lathe. In Fig. 5 both rings are bolted together as one piece and the grooving is continuous from one side to the other.

The two taper sections of the drum are composed of 12 taper segments each, two of which appear in the foreground in Fig. 4, which will give an idea of their size and shape.

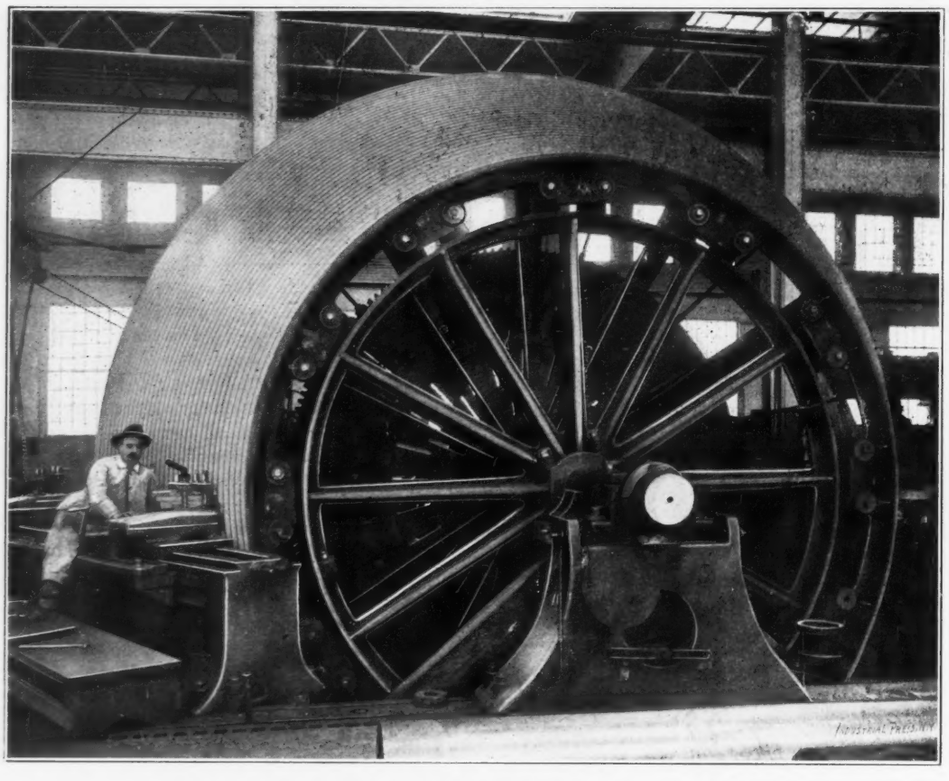


Fig. 3. Front View of Lathe, showing Method of securing the Taper Section of Drum.

It is, of course, somewhat of a problem to properly support the parts of a drum of this size, and the method adopted is quite interesting. The different rings that go to make up the drum are in effect like the rim of a wheel and must be stiffened in practically the same way that a wheel rim is supported, viz., by spokes, which must not only give stiffness to the rim, but must be able to resist the torsional stresses due to the cutting force of the tools. Referring to Fig. 4, it will be seen that a supporting arbor was used, the outer end of which runs in an outboard bearing. There are two sets of spokes for the rim, one set composed of round wrought iron or steel bars like the tension spokes of a bicycle rim, and the

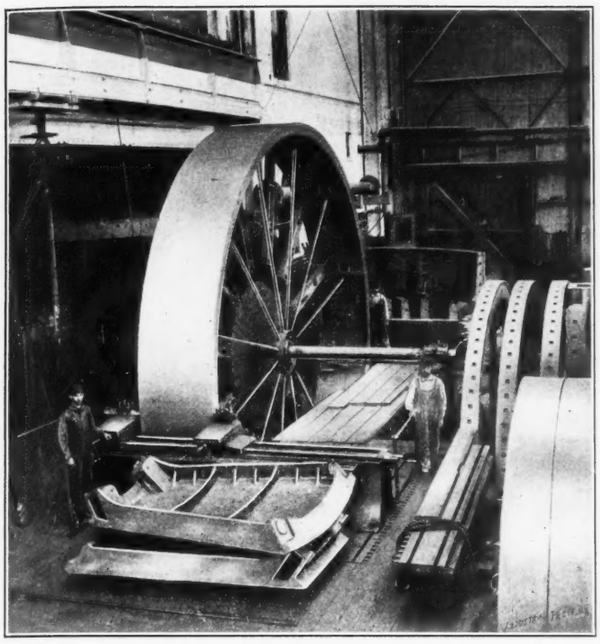


Fig. 4. Turning One-half of Straight Section of Drum.

other set of castings is bolted to the faceplate and made sufficiently heavy to both stiffen the rim and withstand the torsional force. When it came to supporting the wider section of the rim, however, as represented in Fig. 5, an outer spider was placed on the shaft and extension arms were bolted to it like those bolted to the faceplate.

The method of supporting the taper section was identical, except that the spider was of such a diameter that the lugs on its outer circumference could be bolted directly to the flanges on the smaller circumference of the drum.

As mentioned above, this drum is built up of small segments, bolted together, which, while it increases the cost for machining, reduces the labor in the foundry and pattern shop and makes it possible to secure practically perfect castings, an imperfect segment being easily replaced. The method of supporting the drum on its shaft, when in place on the engine bedplate, is different from that usually employed. The shaft itself would ordinarily be made the supporting element and several spiders placed side by side on the shaft would be employed for stiffening the shell and keeping it in position.

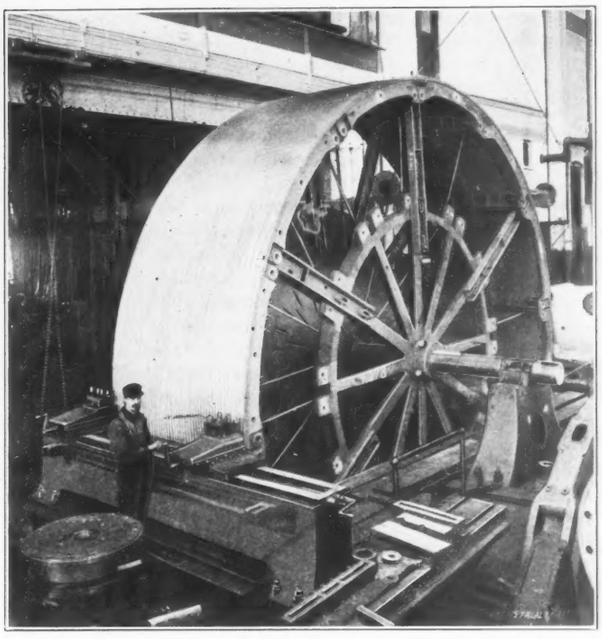


Fig. 5. Grooving Straight Section of Drum.

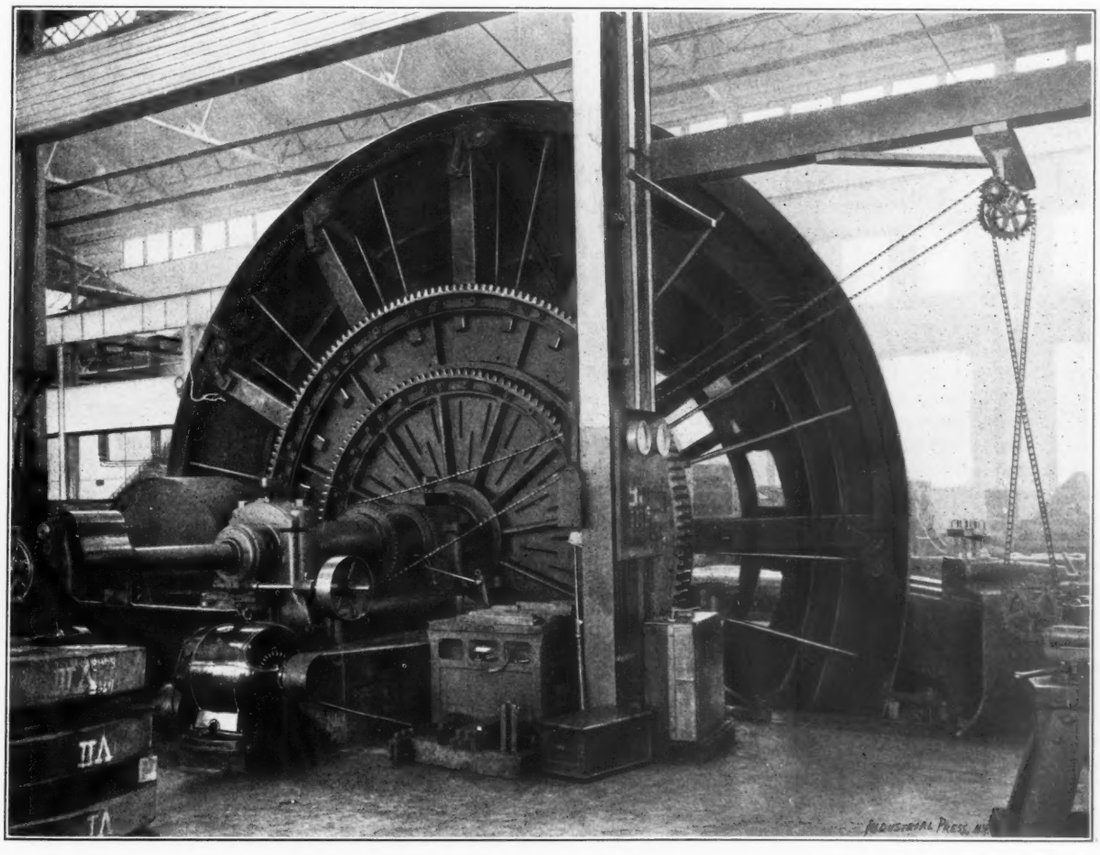


Fig. 6. Rear View of Lathe during Process of Turning one of the Taper Sections.

In the Nordberg drum the supporting element is the shell, which is very rigid, strengthened as it is by the bolt flanges of the different segments. Instead of a series of spiders two flanges or discs are used, one for each end of the drum. These are keyed to the shaft and before being mounted to the shell are brought into parallelism by means of through bolts passing from one disc to the other, thus stiffening the shaft and reducing any tendency to deflection. This being done, the shell segments are placed in position and tension rods are employed to further support the center of the shaft and to increase the rigidity of the drum itself.

It should be mentioned in connection with the drum that the shape in which it is made—taper at each end and straight at the center, as shown in Fig. 1—is a compromise usually adopted with large drums to secure compactness. The hoist is of the balanced type, two cages and two ropes being used, one rope unwinding as the other is wound up. The total weight of one rope when unwound is in this case over 20,000 pounds, or about equal to the combined weights of the cage, cars and ore which are hoisted at one time. When one cage is at the bottom of the shaft the other is at the top and the weight to be supported in one case is therefore double what it is in the other. As one car ascends, the load due to its rope becomes less and less, while the rope supporting the other cage is unwound and the weight due to its rope increases. To keep the cages in perfect balance, so far as the weight of the rope is concerned, and maintain a uniform turning moment for the engines, the drum should evidently be made in the form of two cones, placed base to base. When a cage was at the bottom of its shaft it would be suspended from the small end of its cone, while the other cage, at the top of the shaft, would hang from its cone at its large diameter. Such a design, however, would make necessary a drum of immense proportions, both larger in diameter and longer than the present one. In the compromise adopted the taper portions are carried only half way and each rope in turn winds over the whole width of the straight portion. By utilizing the straight portion for both ropes a substantial saving is made fn the length of the drum; and the diameter, of course, is less than if the taper were carried out to the full extent of the rope's travel. When each rope is on the straight portion the ratio of the weight of its suspended part to the weight of the cage and ore is less than when on the tapered portion, and the effect of the compromise is thus not a serious matter.

* * *

LOCALIZATION OF INDUSTRIES.

In the census bulletin upon the localization of industries, issued this fall, is an extended discussion of the reasons that have led to the concentration of industries of a particular kind in certain localities. Numerous tables are given and the conclusion is drawn that there are seven principal causes for the localization of industries. These are: Nearness to materials, nearness to markets, water power, a favorable climate, a supply of labor, capital available for investment and the momentum of an early start.

One of the most important of the above is the nearness to materials, as shown, for example, by the establishment of the paper industry near the spruce and poplar forests, the tanning industry near the chief tanning materials, the manufacture of agricultural implements near the hardwood forests and iron-producing centers. As the location of the source of these materials has changed, so has the location of the industries changed. As for instance the transference of the manufacturing of agricultural implements to the West.

Of scarcely less importance is the nearness to markets although in general the proportion of the cost in transporting finished products on which labor has been expended is not as great as in transporting raw materials. Nearly 48 per cent. of the manufacturing is done in Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania—mainly because when the industries were started the greatest population was in the eastern states. As the center of population has moved westward, however, so has the center of manufacturing.

Nearness of materials and markets, however, mean more than mere geographical distance; they signify, rather, a general accessibility of the markets as effected by the means of transportation. Thus, the development of railroads, or good water power such as canals or rivers, have enabled industries to receive and ship materials cheaply for considerable distances. In the early history of the country, and to a certain extent to-day, industries tend to group near water power and this early tendency has caused them to continue in their original locations, even when otherwise disadvantageous. This is true of the cotton industry, in which power has been used for more than 100 years. At the beginning of the century steam power was extensive, and the cotton factories were located along the rivers of New England, and the water supplied 31 per cent. of the power used by them. The desirability of locating near the raw materials, however, and the supposed desirability of cheap labor, have caused a recent movement in this field in favor of southern cities, where new cotton mills are being established.

It will be found that in most cases industries have been established in certain localities either through the habit of industrial imitation or else by chance. It is natural that when a workman has become familiar with a certain industry and is ambitious to go into business for himself he should follow the enterprise in which he has been trained. It is also natural that he should establish his plant where there are already workmen skilled in that particular branch; where he has acquaintance with moneyed men who would be likely to furnish backing; and where there has been a practical demonstration that his line of business can be made successful by proper management. Thus it is that an industry having been started in a particular locality becomes a nucleus about which other industries gather. This is well illustrated in the shoe industry which was established in Lynn, Mass., largely through chance. In the early days there was a settlement of cobblers at Lynn who repaired shoes for that region. In 1750 a skilled Welsh shoemaker came to this country and naturally located there, where he began to teach the art of fine shoemaking and this was the beginning of shoe manufacture, the fame of the place spreading gradually from year to year on this account. Machinery was not used in this industry, however, until the middle of the last century, when steam power was comparatively cheap; and so it is that less than 5 per cent. of our shoes are made by water power. It is interesting to note in this connection that of the industries most localized at the present time are those which require the least use of machinery. The introduction of machinery has tended to lessen the importance of any particular class of labor and has made more important the nearness of buying and selling markets.

Although not mentioned in the report, the shifting of the center of machine tool manufacturing from the east to the west is typical of the changes that have quite generally taken place. Formerly iron and steel came mainly from New Jersey and Pennsylvania, or from abroad. The selling market was in the east and the machine tool centers were at Fitchburg, Worcester, Newark, Philadelphia and other eastern cities. The large proportion of labor cost and the small proportion of material cost entering into such tools have made it possible for these centers to hold their own, and even to increase their output. But with the shifting of the population westward and the development of the iron and steel industries of the west has also come the shifting of the center of machine tool manufacturing to the west through the development of industries in Cincinnati, Cleveland and other western cities.

* * *

A writer quoted in the *American Shipbuilder* says that the fuel consumption of two steamships, one of, say, 8,000 tons displacement and the other of 26,000 tons, will be in the proportion of about 7 or 8 pounds per 100-ton mile for the former as against 5 pounds per 100-ton mile for the latter vessel. This comparison, of course, assumes that the engines are of equal efficiency. When it is considered that the chief item of expense in the operation of ocean vessels is the cost of the fuel, it will at once be understood why these vessels are more advantageous than the smaller ones provided the volume of freight is sufficient to give the large ones full lading. The personnel of the large ship is not much greater in number than that of the small one.

STEEL AND ITS TREATMENT.—5.

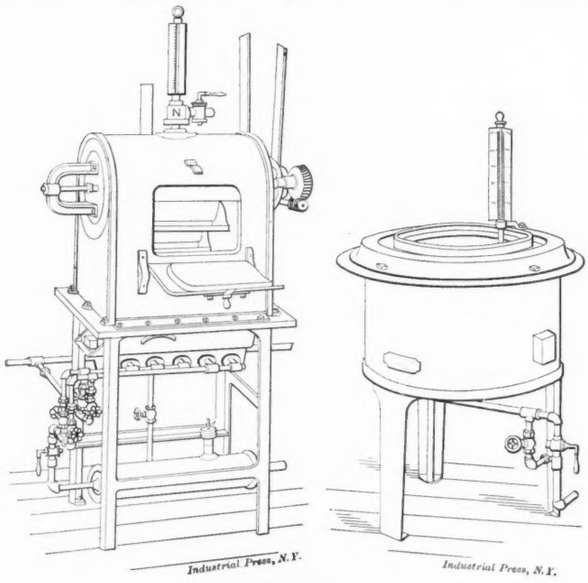
EXAMPLES OF HARDENING AND TEMPERING.

E. R. MARKHAM.

Tool steel is hardened by heating red hot and plunging in some cooling bath; and as previously explained the nature of the bath depends on the character of the work to be hardened. It is necessary that steel used for cutting tools should be hard enough to do the work expected of them, and strong enough to stand up when subjected to the heaviest cuts and feeds they are to take. Now, tool steel suitable for cutting and similar tools, should be of a kind specially adapted for this class of work, and should harden at a *low* red heat.

When hardening, the amount of heat necessary for steel varies with steels of different makes, and with steels of various percentages of *carbon*. To accomplish certain results the steel maker puts other hardening elements into steel with carbon; these steels generally harden at a lower temperature than ordinary carbon steel. The lowest heat at which a piece of steel will harden in a satisfactory manner is called the *refining* heat, because when the piece is broken the grain shows it to have been refined. Steel hardened at this heat is very hard and strong and the grain is the finest possible.

Heating a piece of steel red hot and cooling quickly not only makes it *hard* but also makes it *brittle;* and the higher



Figs. 1 and 2.

the heat when the piece was hardened the more brittle the steel will be. If steel is heated higher than at refining heat it is much more brittle. To reduce the amount of brittleness, the piece must be reheated, and this process of re-heating is termed tempering. The process of heating to temper is necessarily a softening one. Ordinarily it is desirable to leave cutting tools as hard as possible, but in this condition they are too brittle to stand up. It is evident that there is nothing gained in heating steel above the refining heat, and then drawing the temper to a degree that makes it much softer than when it came from the bath after quenching at the proper heat. Thus, it will be seen that the ability of a tool to stand up to the work depends greatly on the heat it receives when hardening.

To obtain good results steel must be uniformly heated. If one part of a piece is heated hotter than some other part violent strains are set up in the piece, and it is very liable to crack. Uneven heating is probably the cause of a large percentage of the steel cracked in hardening. Heats that are too high cause unnecessary brittleness and open grain.

The methods of heating steel and the baths used in quenching have been considered in former articles; we will now take up the methods ordinarily used in drawing the temper, before proceeding to the hardening and tempering of tools.

The more common way, when the article is taken from the hardening bath, is to brighten one or more of its surfaces with a buff stick. This is made by covering a stick with glue and then adding emery until the surfaces are covered; or a piece of emery cloth may be glued or tacked to the stick, or held on a file. When the steel is exposed to the action of heat various colors appear on the brightened surface. The colors furnish an unvarying guide as to the amount of heat absorbed by the steel. They do not necessarily show how hard the piece of steel may be; because a piece of soft tool steel, or even a piece of iron will show the same colors if brightened and exposed to the same amount of heat. But they do denote the amount of heat a hardened piece has received, and as a certain amount of heat is necessary to produce a desired result (provided the pieces are of an equal hardness to start with) it shows that the amount we reduce the brittleness may be very readily gaged by the temper colors. However, a piece of steel hardened at an extremely low red would not be in the same condition as a piece cut from the same bar and heated to a yellow, even if both pieces were reheated to the same temper color. Here, again, we see the necessity of hardening at the lowest possible heat, and as nearly as possible at the same heat.

The tempering heat may be applied by holding the article over the fire of an ordinary forge, turning it in order to insure uniform heating. Or if the shape of the piece makes it possible, it may be drawn by placing on a hot plate, moving it around and turning it occasionally to heat evenly. Or it may be placed in a pan of hot sand, keeping the sand and articles in motion by shaking the pan. But if the article has teeth or projections which would be injured by striking the other pieces, the pieces may be moved in the sand with a stick, care being taken not to strike them together.

A good method consists in placing them in the revolving pans of a furnace such as shown in Fig. 1. This furnace is provided with a thermometer for gaging the degree of heat in the furnace. The degree of heat registered in this way by the thermometer does not necessarily determine the amount of heat the steel has received; but if one observes the amount registered it serves as a guide, and when it is ascertained what results are obtained with a certain heat these results may be had at any time by heating the furnace so the thermometer registers the required amount. The temperature being no higher than necessary the heavy portions of a piece may be given the required temper without drawing the lighter portions too much.

A method of drawing the temper giving universal satisfaction consists in placing the articles in a kettle of oil, heated to the proper temperature, the heat being gaged by a thermometer, which in this case is partly immersed in the oil, the bulb being at the same height as the work being heated. Furnaces burning illuminating gas, of the pattern illustrated in Fig. 2, give excellent results. But one may be made on the premises at a low cost, that will burn hard coal as fuel. This method furnishes a very cheap means of drawing work done in large quantities, and of doing it very uniformly, as many thousand small pieces may be tempered in a day at a temperature varying not more than one or two degrees.

When very large pieces of steel are to be hardened, some means of heating should be provided for heating the article uniformly, for if the edges and corners are hotter than the balance of the block it is very liable to crack when quenched in the bath, owing to unequal contraction of the piece when cooling. When steel is heated red hot and plunged in a liquid, vapors are formed which have a tendency to keep the contents of the bath away from the work, thus preventing cooling. In order that the liquid may act quickly enough some means must be devised of getting rid of the steam or vapor. When small pieces are being hardened this may be accomplished by moving them up or down, or around in the bath; but, of course, with a heavy piece this would be impossible, so the water or other liquid must be forced against the piece with sufficient force to drive the vapors away and give the liquid a chance to absorb the heat in the steel.

For the hardening of large dies such as those used in drop forge work, a bath may be used having a jet coming up from the bottom, which should strike the face of the die with con-

siderable force. When the die has cooled to the temperature of the bath it is taken out and subjected to heat to remove the tendency to crack from strain. On account of the immense amount of liquid needed for use when hardening work of this description, it is generally necessary to use clear water in the bath. For hardening dies used for punching blanks in punch presses, it is advisable to fill all screw, dowel-pin, and stop-pin holes with fire clay mixed with water to the consistency of dough. This prevents the contents of the bath acting at these points and causing cracks, especially in the holes having threads.

It is extremely important that a die of this kind be heated *very uniformly*, and *no hotter* than is necessary. Dies of this description harden at a lower heat than articles having no openings, even when made from the same bar of steel.

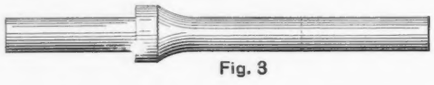


Fig. 3

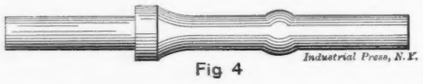


Fig 4

Figs. 3 and 4. Punch Improperly Hardened.

It is well to dip the die in a bath which has been warmed somewhat, the temperature depending on the shape of the die and the percentage of carbon in the steel. If the die is of a shape that makes it liable to crack when hardened it should not be left in the bath of water until cold, but should be removed when it is hardened on the surface and immediately plunged in a tank of oil and left there till it has cooled to the temperature of the bath. Then it may be heated to remove the tendency to crack from internal strains.

There are various methods used when drawing the temper of dies and similar pieces. The one most commonly used consists in placing the die on a piece of flat iron or steel heated to a degree. Many hardeners heat the plate red hot and place the hardened die on this. It is, of course, necessary to brighten the face of the die previous to drawing the temper in order that the temper colors may be visible. It is also necessary to move the die on the plate and to turn it over occasionally to insure uniform heating, although most of the heat should be applied to the bottom of the die. The amount necessary to draw a die of this kind depends on the steel used in its construction, the shape of the die, the *amount* of heat given when hardening, and the nature of the work to be done by the die. If made of low carbon steel it must not be drawn as much as if high-carbon stock were used; if it were heated above a refining heat it would be

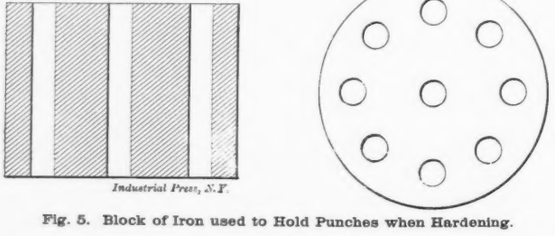


Fig. 5. Block of Iron used to Hold Punches when Hardening.

more brittle than if properly heated, and consequently would require drawing lower, which would impair its usefulness. If the shape is such that portions of it are weak it must be drawn lower than if it were strong. If it is to receive very rough usage it must be drawn more than if not to be subjected to any great amount of strain.

No given color or degree of temperature can be arbitrarily given as an indication of the proper amount a die should be drawn, as there are so many things to be considered. Sometimes all that is required is to heat them enough to remove the tendency to crack from internal strains, while at other times it may be necessary to draw until the surface is a deep brown with purple spots showing. For ordinary work, however, if hardened at the proper heat a full straw to a brown color will be found sufficient range. The punch to be used with the die should be drawn somewhat lower than the die. When hardening a punch it is necessary to take into consideration its shape and the nature of the work it is to do. If the punch is long and slender as shown in Fig. 3 it is, generally speaking, necessary to harden the entire length of the slender part, to make it as stiff as possible and do away with any tendency to spring. Then again if the punch was to be used in punching very hard stock—that is, heavy as compared to the diameter of the punch—it would be necessary to harden as described, to overcome any tendency of the stock to compress or "buckle." If a punch of the design shown in Fig. 3 were hardened to the point represented by the dotted line, and the balance left soft, it would, if used on stock as large in diameter as the punch, assume the shape shown in Fig. 4; whereas if it were hardened for a distance that made it possible for it to resist the immense pressure, it would remain straight.

When drawing the temper of punches having shanks as shown in sketch, it is customary in some shops to drill holes in a heavy piece of iron as indicated in Fig. 5, and to place the shanks of the punches in these holes having previously heated the block red hot. The heat starting from the shank end travels toward the cutting end. This answers very nicely if the punches are to be used on light or very soft material; but if the stock is heavy or hard, the punch must be about the same degree of hardness the entire length of the portion that must resist pressure. When drawing the temper it may be held in the flame of a gas jet, spirit lamp, Bunsen burner or anywhere that it will be subjected to a sufficient amount of heat to accomplish the purpose. However if there are many punches to be tempered this is costly as well as unsatisfactory, and the furnace shown in

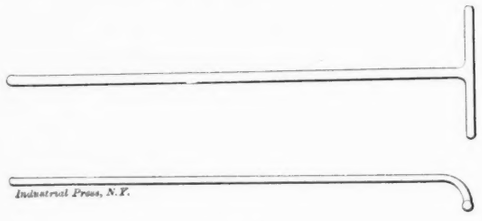


Fig. 6.

Fig. 1 will furnish a means of doing this work with very good results at a reasonable cost per piece. Probably the most satisfactory method consists in heating in a kettle of oil, gaging the heat by a thermometer as referred to under description of oil tempering furnaces, illustrated in cut Fig. 2. The amount of heat necessary to give the pieces when tempering depends on the conditions previously mentioned. It should be borne in mind that slender punches intended for piercing stock as thick as the diameter of the punch are necessarily subjected to immense strain, consequently the steel should be the strongest possible, and this can only be accomplished by careful heating when hardening. If the punch is heated above the refining heat it is more brittle than if properly heated.

Articles that need to be toughened in order to resist strain should, if possible, be heated slowly when drawing the temper; it is advisable to let them cool off slowly also, that is they should not be quenched unless they show a disposition to become too soft, in which case they should be quenched in oil rather than water.

As previously explained, articles of irregular contour, or of a form that causes trouble when the piece is hardened, should, if possible, be annealed after blocking out to shape. Milling machine cutters, especially those of irregular shape, occasion a great deal of trouble in some shops. The teeth projecting from the main body of the stock are much more sensitive to the action of heat than the balance of the piece; consequently they are liable to become hotter than is necessary to obtain good results. If the teeth are hotter than the body of the cutter, then they are expanded more than the other portion, and when cooled in the bath they contract differently, and, as previously stated, unequal contraction is the cause of a large percentage of cracks in hard-

ened steel. If the whole cutter is heated hotter than is necessary, but is heated uniformly, it may not crack, but it will not be as strong as it might be.

It is advisable to heat such tools to the lowest uniform heat possible. When properly heated place on a wire bent at one end in the form of a T as shown in Fig. 6; they should be plunged into a bath of luke-warm water or brine and left there until it ceases "singing," when they may be removed and instantly plunged into a tank of oil and left until cooled to the temperature of the bath. When brightening the teeth in order to readily observe the temper colors, it is advisable to brighten the backs rather than the faces, as in this way there is no danger of injuring the cutting edges.

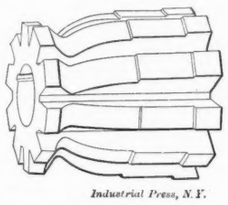


Fig. 7. Formed Milling Cutter.

It is the general custom in most shops to draw the temper of milling machine cutters by placing them on a plug somewhat smaller than the hole in the cutter, the plug having previously been heated red hot. The cutter should be constantly turned. When the proper temper color shows, the cutter may be removed from the plug and immersed in oil, to prevent its becoming too soft from the heat in the cutter near the hole which was exposed to the red hot iron. The necessary temper at which to draw the cutter depends on the nature of the stock to be milled; however, in most shops they are drawn to a temperature that varies from 430 degrees to 460 degrees, which is equivalent to from a faint straw to a full straw color.

When hardening *formed* mills, Fig. 7, it is not generally necessary to draw the temper, provided the cutter has been hardened at the refining heat. The tooth being heavy is strong enough to resist the strain incident to cutting the stock. Long articles such as reamers, etc., require extra care when heating for hardening. Their diameter not being in proportion to their length makes them especially liable to spring from unequal heating. They are also very liable to spring when dipped in the bath, unless held in as nearly a vertical position as possible. As stated in a former article, stock for tools of this description should never be straightened when cold as it is almost sure to spring when hardened. And the stock should be thoroughly annealed, after the outside surface has been removed. The bath for hardening tools of this description should be heated somewhat; cold baths are very liable to cause springing and cracking. If the articles are so long that uniform results seem impossible to obtain when drawing by the ordinary methods, place them in a pan of oil, heating the oil and gaging the heat by a thermometer as described.

Taps, on account of the weakness of the teeth (threads) which project from the body of the tool, should be heated in a manner that makes them as strong as possible. The teeth must not be overheated, because if overheated they become extremely brittle and break off when in use. After hardening, the flutes should be ground with an emery wheel of the proper shape. This grinding has the effect of giving the cutting portions a sharp edge; it will also break the burrs which form between the teeth from the action of the milling cutter used in cutting the flutes. It also brightens the stock sufficiently to enable one to readily observe the temper colors. If only a few taps are to be tempered they may be heated in a flame, applying the heat to the shank end. If there are many to draw it is best to use a kettle of oil. Taps are drawn to deep straw color for most work.

Hollow mills or similar tools having holes running *part way* through them, should be dipped in the bath with the cutting teeth uppermost, that the contents of the bath may readily enter the hole. Then again it is best to harden the frailest part of such a tool *last*, when possible, for if the weakest part is hardened first it would be rigid by the time the heavier portions were hardened, and the heavier and stronger parts would draw the lighter portions somewhat and these being hard and unyielding would crack.

When tempering these articles heat should be applied at the shank end, allowing it to run toward the cutting edges. If the tool is to cut hard metals a faint straw color will be satisfactory; if softer metals are to be machined it is best to draw to a full straw as they can be forced harder.

Thin saws for cutting metals are hardened by carefully heating and placing between plates whose surfaces are smeared with oil. A flat surface should be provided upon which to lay them when in the fire, which may be accomplished by using a flat plate, either of cast-iron or machine steel, one surface of which has been machined flat. This precaution is taken to prevent the piece springing when heating. When it has reached a uniform red heat, which should be as low as possible, the saw may be taken from the fire and laid on the plate mentioned, putting the upper plate on the saw as soon as possible. To place the upper plate in position before the saw has become cooled enough to crook, it should be handled by a second operator. But where very many saws are hardened at a time by this method it is possible to make a fixture consisting of two plates. The lower one is located in a pan of oil and the upper one has a rope attached to it which runs over a pulley fixed overhead. It should then return and be attached to a treadle under the bench. By this means the upper plate can be raised sufficiently to allow the heated saw to be laid on the lower plate, and then the upper one may be lowered onto it. For a fixture of this description two rods, like those shown in Fig. 8 are needed. The lower ends of the rods are stationary with the lower plate. Holes somewhat larger are drilled in the upper one so that the plate may readily be moved up and down.

While it is possible to brighten such articles and draw the temper by observing the colors, if there is a quantity of them it is costly and unsatisfactory. For a large number place in a kettle of oil, drawing the temper to a degree that will adapt the saw to the work it is to do. If it is a metal-slitting saw for cutting tool steel and is to be used in a power milling machine, it may be drawn to 460 degrees; if to be used for general jobbing it should be drawn somewhat lower, say from 480 degrees to 500 degrees. Screw-slotting saws, if 1-16-inch thick or under, show good results when drawn to 525 degrees; if thicker than 1-16-inch they may be left.

When drawing the temper of these articles place them in the oil before it is very hot, as the sudden expansion of a hardened piece of the diameter of a saw used for ordinary machine shop work would cause it to crack. For this reason it is well to put them into comparatively cool oil, heating

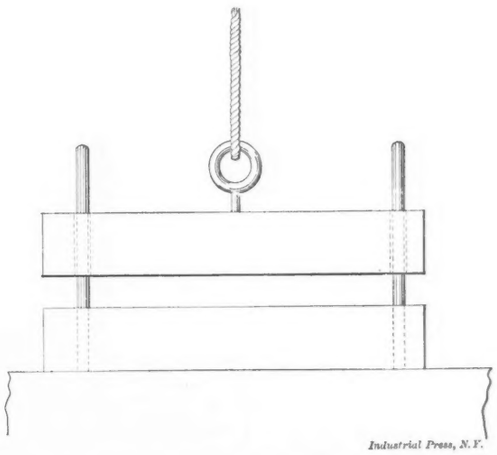


Fig. 8. Fixture Convenient for use when Hardening Saws.

it to the desired degree, when the kettle may be removed and placed where the work and oil may cool off gradually.

For the instruction of any not familiar with the various degrees of heat necessary to produce given results when drawing the temper by heating in oil, the following table is given:

	Degrees.		Degrees.
Faint straw color	430	Dark purple	550
Straw color	460	Pale blue	610
Brown yellow	500	Clear blue	570
Light purple	530	Blue tinged with green	630

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1903.

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WHAT OF THE LARGE GAS ENGINE?

It is the purpose of MACHINERY to record from month to month the important steps in the mechanical progress of the times. The most significant event of the past month is the starting of the first of the large gas engines now being installed at the works of the Lackawanna Steel Co., Buffalo, as told in the first article of this number—an installation of exceptional interest in points of novelty, size and in the fact that the engines are to be operated by blast furnace gas.

A conservative estimate of the amount of energy available in blast furnace gas places the number of cubic feet of gas generated, per ton of pig iron produced, at 159,000. Of this, about 50 per cent. must be consumed in heating the blast, and by leakage. If we assume roughly, that 75,000 cubic feet are available for the blowing engines or other power purposes, at the rate of 100 cubic feet per horse-power hour, 750 horse power could be obtained per ton of pig iron. Figures given by W. H. Booth, the English engineer, make even a better showing. He estimates that 96,000 cubic feet of gas can be utilized per ton of pig, and that the engines will run on 91 cubic feet of gas per horse-power hour, giving an available horse power of over 1,000 per ton of iron. It is evident that the resources of a plant having several 400-ton blast furnaces would be very great.

The analysis of blast furnace gas shows it to be composed of the same constituents as producer gas, though in different proportions, the former being richer in carbonic oxide, the heat-giving element. The calorific power of blast furnace gas is only about one-tenth that of natural gas. This is partly because the former has a large percentage of nitrogen, the effect of which is negative, so far as combustion is concerned; and partly because natural gas is largely composed of Marsh gas, which has a calorific capacity of 23,000 B. T. U., as against 4,000 units per pound for the smaller amount of carbonic oxide in the blast furnace gas. The composition of blast furnace gas, however, is not entirely against it when compared with the richer gases, because it is less inflammable, permitting a higher degree of compression in the gas engine cylinder without danger of premature ignition. A larger charge of blast furnace gas can be safely used at each stroke than with natural gas, so that, in spite of the low calorific power of the former, the size of engine cylinder necessary to get the requisite power from the poorer gas need not be as great as would appear.

Statistics, recently quoted by Prof. J. J. Flatner, indicate to how great an extent Europe is ahead of us in large gas engine construction. A list of engines in use or building in the whole of Europe, neglecting those under 200 horse power, shows a total of 327 engines capable of supplying 182,000 horse power, an average of 560 horse power. In the United States in 1899 the total horse power constructed aggregated 165,000, but only nine horse power per engine. There is, however, a constant tendency toward larger work. Gas engines of 1,000 or more horse power each have already been made in this country by the Snow Steam Pump Works, Buffalo, and the De La Vergne Refrigerating Machine Co., New York, and engines of this power are in course of construction by the Westinghouse Machine Co., Pittsburg, and Struthers, Wells & Co., Warren, Pa. Other builders are also producing engines of several hundred horse power.

What are the prospects, then, for the more extended use of large-size engines? Blast furnace gas and natural gas are limited commodities, of course, and the large gas engine must be used with producer gas in most sections of the country. But the economy of the large gas engine with producer gas is not particularly better than the economy of the steam engine of corresponding power, at the present state of the art, reckoning in each case from the coal consumed. The original cost of the two plants—including the producer in one case and the boiler in the other—is nearly identical; and while each *may* develop a horse power on less than two pounds of coal per horse-power hour, we think neither is likely to go much below this figure in ordinary running. Under variable loads we believe the steam engine to be the more economical. In the case of small powers the gas engine, of course, easily leads, since the full economy of steam is not realized with small engines.

* * *

NOTES AND COMMENT.

"It is somewhat amoosin'" to note the attention that has been given by various publications, technical and otherwise, to John Jacob Astor's recent gift to the public of his steam turbine patents. While we do not wish to cast doubts on John Jacob's generosity, we somehow cannot help thinking that the dear public will never reap any great return from his munificence in this particular instance. The design of this turbine appears to one who has given the matter considerable consideration to be highly impracticable to say the least.

The day of small things seems to be fast fading away—at least in the minds of stock jobbers. Some years ago a needle was invented that can be threaded by drawing a loop of the thread along one side, opposite the eye, a narrow slot through the side being provided which makes threading in the ordinary manner unnecessary. Needles can be threaded with your eyes shut. It now appears that this simple scheme is worth an untold fortune and stock is being offered to the confiding public at $10 per share as a RARE investment. From the profits on needles sold in four months, it is calculated that a yearly profit of 60 per cent. will be netted on $1,000,000 capital. Investments *can be* made with your eyes shut, too.

Of course all boiler explosions are not preventable by the exercise of practicable methods of inspection and care, but, in the light of many subsequent investigations, it is quite safe to affirm that the great majority of them are. A city water supply pumping station boiler recently exploded with great violence in Queens Borough, Greater New York, that in all probability did so because of lax methods of inspection. The water used in the boilers was well-known to be of a corrosive nature, yet so lax were the inspection methods that the steel plates of the boiler, originally ⅜-inch thick, were allowed to be eaten away at the water line until they were less than 1-16 inch thick in places. Two men having large families were instantly killed.

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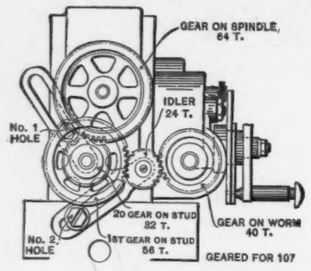
INDEX TABLE FOR PLAIN AND DIFFERENTIAL INDEXING,



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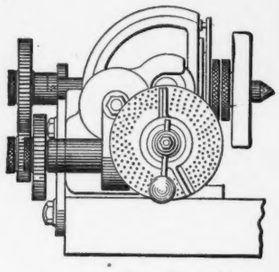

EXAMPLE: REQUIRED TO INDEX FOR 107 DIVISIONS.

If we use the plate having 20 holes and move 8 holes per division, 100 moves will be required to rotate the worm 40 turns, which in turn rotates the spindle once. If we made 107 moves, with the index plate fixed, we would obtain $107 \times \frac{8}{20} = 42.8$ revolutions of the worm, which is 2.8 in excess of what is required. Therefore the index plate must be geared so that it will move back 2.8 turns, while the spindle is revolving once; that is, the ratio of the gearing must be 2.8 to 1.

$$\frac{2.8}{1} = \frac{2.8}{2} \times \frac{2}{1}$$

$$\frac{2.8}{2} \times \frac{20}{20} = \frac{56}{40} \qquad \frac{2}{1} \times \frac{32}{32} = \frac{64}{32}$$

Then $\frac{2.8}{1} = \frac{56}{40} \times \frac{64}{32}$ and our gears will be 64 and 56 for the spindle and first gear on stud, and 40 and 32 for the worm and second gear on stud.

As compound gears are used, but one idler is required to cause the index plate to move in a direction opposite to that of the crank. For this purpose an idler having 24 teeth is employed.

For further information see article on "Differential Indexing," in MACHINERY for January, 1903.

Number of Divisions.	Index Circle.	No. of Turns of Index.	Gear on Worm.	No. 1 Hole. First Gear on Stud.	No. 1 Hole. Second Gear on Stud.	Gear on Spindle.	Idlers. No. 1 Hole.	Idlers. No. 2 Hole.
2	Any	20						
3	39	$13\frac{13}{39}$						
4	Any	10						
5	"	8						
6	39	$6\frac{6}{39}$						
7	49	$5\frac{35}{49}$						
8	Any	5						
9	27	$4\frac{9}{27}$						
10	Any	4						
11	33	$3\frac{21}{33}$						
12	39	$3\frac{12}{39}$						
13	39	$3\frac{3}{39}$						
14	49	$2\frac{42}{49}$						
15	39	$2\frac{30}{39}$						
16	20	$2\frac{16}{20}$						
17	17	$2\frac{6}{17}$						
18	27	$2\frac{18}{27}$						
19	19	$2\frac{14}{19}$						

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Number of Divisions.	Index Circle.	No. of Turns of Index.	Gear on Worm.	No. 1 Hole. First Gear on Stud.	No. 1 Hole. Second Gear on Stud.	Gear on Spindle.	Idlers. No. 1 Hole.	Idlers. No. 2 Hole.
134	21	$6\frac{}{21}$	28			48	44	
135	27	$7\frac{}{27}$						
136	17	$5\frac{}{17}$						
137	21	$6\frac{}{21}$	28			24	56	
138	21	$6\frac{}{21}$	56			32	44	
139	21	$6\frac{}{21}$	56	32	48	24		
140	49	$14\frac{}{49}$						
141	18	$5\frac{}{18}$	48			40	44	
142	21	$6\frac{}{21}$	56			32	24	44
143	21	$6\frac{}{21}$	28			24	24	44
144	18	$5\frac{}{18}$						
145	29	$8\frac{}{29}$						
146	21	$6\frac{}{21}$	28			48	24	44
147	21	$6\frac{}{21}$	24			48	24	44
148	37	$10\frac{}{37}$						
149	21	$6\frac{}{21}$	28			72	24	44
150	15	$4\frac{}{15}$						
151	20	$5\frac{}{20}$	32			72	44	
152	19	$5\frac{}{19}$						
153	20	$5\frac{}{20}$	32			56	44	
154	20	$5\frac{}{20}$	32			48	44	
155	31	$8\frac{}{31}$						
156	39	$10\frac{}{39}$						
157	20	$5\frac{}{20}$	32			24	56	
158	20	$5\frac{}{20}$	48			24	44	
159	20	$5\frac{}{20}$	64	32	56	28		
160	20	$5\frac{}{20}$						
161	20	$5\frac{}{20}$	64	32	56	28		24
162	20	$5\frac{}{20}$	48			24	24	44
163	20	$5\frac{}{20}$	32			24	24	44
164	41	$10\frac{}{41}$						
165	33	$8\frac{}{33}$						
166	20	$5\frac{}{20}$	32			48	24	44
167	20	$5\frac{}{20}$	32			56	24	44
168	21	$5\frac{}{21}$						
169	20	$5\frac{}{20}$	32			72	24	44
170	17	$4\frac{}{17}$						
171	21	$5\frac{}{21}$	56			40	24	44
172	43	$10\frac{}{43}$						
173	18	$4\frac{}{18}$	72	56	32	64		
174	18	$4\frac{}{18}$	24			32	56	
175	18	$4\frac{}{18}$	72	40	32	64		
176	18	$4\frac{}{18}$	72	24	24	64		
177	18	$4\frac{}{18}$	72			48	24	
178	18	$4\frac{}{18}$	72			32	44	
179	18	$4\frac{}{18}$	72	24	48	32		
180	18	$4\frac{}{18}$						
181	18	$4\frac{}{18}$	72	24	48	32		24
182	18	$4\frac{}{18}$	72			32	24	44
183	18	$4\frac{}{18}$	48			32	24	44
184	23	$5\frac{}{23}$						
185	37	$8\frac{}{37}$						
186	18	$4\frac{}{18}$	48			64	24	44
187	18	$4\frac{}{18}$	72	48	24	56		24
188	47	$10\frac{}{47}$						
189	18	$4\frac{}{18}$	32			64	24	44
190	19	$4\frac{}{19}$						
191	20	$4\frac{}{20}$	40			72	24	
192	20	$4\frac{}{20}$	40			64	44	
193	20	$4\frac{}{20}$	40			56	44	
194	20	$4\frac{}{20}$	40			48	44	
195	39	$8\frac{}{39}$						
196	49	$10\frac{}{49}$						
197	20	$4\frac{}{20}$	40			24	56	
198	20	$4\frac{}{20}$	56	28	40	32		
199	20	$4\frac{}{20}$	100	40	64	32		
200	20	$4\frac{}{20}$						
201	20	$4\frac{}{20}$	72	24	40	24		24
202	20	$4\frac{}{20}$	72	24	40	48		24
203	20	$4\frac{}{20}$	40			24	24	44
204	20	$4\frac{}{20}$	40			32	24	44
205	41	$8\frac{}{41}$						
206	20	$4\frac{}{20}$	40			48	24	44
207	20	$4\frac{}{20}$	40			56	24	44
208	20	$4\frac{}{20}$	40			64	24	44
209	20	$4\frac{}{20}$	40			72	24	44
210	21	$4\frac{}{21}$						
211	16	$3\frac{}{16}$	64			28	44	
212	43	$8\frac{}{43}$	86	24	24	48		
213	27	$5\frac{}{27}$	72			40	44	
214	20	$3\frac{}{20}$	40	56	32	64		24
215	43	$8\frac{}{43}$						
216	27	$5\frac{}{27}$						
217	21	$4\frac{}{21}$	48			64	24	44
218	16	$3\frac{}{16}$	64			56	24	44
219	21	$4\frac{}{21}$	28			48	24	44
220	33	$6\frac{}{33}$						
221	17	$3\frac{}{17}$	24			24	56	
222	18	$3\frac{}{18}$	24			72	44	
223	43	$8\frac{}{43}$	86	48	24	64		24
224	18	$3\frac{}{18}$	24			64	44	
225	27	$5\frac{}{27}$	24			40	24	44
226	18	$3\frac{}{18}$	24			56	44	
227	49	$9\frac{}{49}$	56	64	28	72		
228	18	$3\frac{}{18}$	24			48	44	
229	18	$3\frac{}{18}$	24			44	48	
230	23	$4\frac{}{23}$						
231	18	$3\frac{}{18}$	32			48	44	
232	29	$5\frac{}{29}$						
233	18	$3\frac{}{18}$	48			56	44	
234	18	$3\frac{}{18}$	24			24	56	
235	47	$8\frac{}{47}$						
236	18	$3\frac{}{18}$	48			32	44	
237	18	$3\frac{}{18}$	48			24	44	
238	18	$3\frac{}{18}$	72			24	44	
239	18	$3\frac{}{18}$	72	24	64	32		
240	18	$3\frac{}{18}$						
241	18	$3\frac{}{18}$	72	24	64	32		24
242	18	$3\frac{}{18}$	72			24	24	44
243	18	$3\frac{}{18}$	64			32	24	44
244	18	$3\frac{}{18}$	48			32	24	44
245	49	$9\frac{}{49}$						
246	18	$3\frac{}{18}$	24			24	24	44
247	18	$3\frac{}{18}$	48			56	24	44

x 9 DATA SHEETS.

These data sheets are intended to be cut into four sections, 6 x 9 inches in size, as indicated by the straight lines. They may then be bound into note book form for convenient reference by means of staples inserted in holes punched at the points indicated.

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Number of Divisions.	Index Circle.	No. of Turns of Index.	Gear on Worm.	No. 1 Hole. First Gear on Stud.	No. 1 Hole. Second Gear on Stud.	Idlers. Gear on Spindle.	Idlers. No. 1 Hole.	Idlers. No. 2 Hole.
20	Any	2						
21	21	1 19/21						
22	33	1 27/33						
23	23	1 21/23						
24	39	1 15/39						
25	20	1 12/20						
26	39	1 13/39						
27	27	1 12/27						
28	49	1 21/49						
29	29	1 11/29						
30	39	1 9/39						
31	31	1 9/31						
32	20	1 8/20						
33	33	1 11/33						
34	17	1 8/17						
35	49	1 14/49						
36	27	1 9/27						
37	37	1 3/37						
38	19	1 1/19						
39	39	1 1/39						
40	Any	1						
41	41	40/41						
42	21	20/21						
43	43	40/43						
44	33	32/33						
45	27	24/27						
46	23	20/23						
47	47	40/47						
48	18	16/18						
49	49	40/49						
50	20	16/20						
51	17	14/17	24			48	24	44
52	39	30/39						
53	49	35/49	56	40	24	72		
54	27	20/27						
55	33	24/33						
56	49	35/49						
57	21	15/21	56			40	24	44
58	29	20/29						
59	39	26/39	48			32	44	
60	39	26/39						
61	39	26/39	48			32	24	44
62	31	20/31						
63	39	24/39	24			48	24	44
64	16	10/16						
65	39	24/39						
66	33	20/33						
67	21	12/21	28			48	44	
68	17	10/17						
69	20	12/20	40			56	24	44
70	49	30/49						
71	18	10/18	72			40	24	
72	27	15/27						
73	21	11/21	28			48	24	44
74	37	20/37						
75	15	8/15						
76	19	10/19						
77	20	10/20	32			48	44	
78	39	20/39						
79	20	10/20	48			24	44	
80	20	10/20						
81	20	10/20	48			24	24	44
82	41	20/41						
83	20	10/20	32			48	24	44
84	21	10/21						
85	17	8/17						
86	43	20/43						
87	15	7/15	40			24	24	44
88	33	15/33						
89	18	8/18	72			32	44	
90	27	12/27						
91	39	17/39	24			48	24	44
92	23	10/23						
93	18	8/18	24			32	24	44
94	47	20/47						
95	19	8/19						
96	21	9/21	28			32	24	44
97	20	8/20	40			48	44	
98	49	20/49						
99	20	8/20	56	28	40	32		
100	20	8/20						
101	20	8/20	72	24	40	48		24
102	20	8/20	40			32	24	44
103	20	8/20	40			48	24	44
104	39	15/39						
105	21	8/21						
106	43	16/43	86	24	24	48		
107	20	8/20	40	56	32	64		24
108	27	10/27						
109	16	6/16	32			28	24	44
110	33	12/33						
111	39	14/39	24			72	32	
112	39	14/39	24			64	44	
113	39	14/39	24			56	44	
114	39	14/39	24			48	44	
115	23	8/23						
116	29	10/29						
117	39	13/39	24			24	56	
118	39	13/39	48			32	44	
119	39	13/39	72			24	44	
120	39	13/39						
121	39	13/39	72			24	24	44
122	39	13/39	48			32	24	44
123	39	13/39	24			24	24	44
124	31	10/31						
125	39	13/39	24			40	24	44
126	39	13/39	24			48	24	44
127	39	13/39	24			56	24	44
128	16	5/16						
129	39	13/39	24			72	24	44
130	39	13/39						
131	20	6/20	40			28	44	
132	33	10/33						
133	21	6/21	24			48	44	

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Number of Divisions.	Index Circle.	No. of Turns of Index.	Gear on Worm.	No. 1 Hole. First Gear on Stud.	No. 1 Hole. Second Gear on Stud.	Idlers. Gear on Spindle.	Idlers. No. 1 Hole.	Idlers. No. 2 Hole.
248	31	5/31						
249	18	9/18	32			48	24	44
250	18	12/18	24			40	24	44
251	18	12/18	48	44	32	64		24
252	18	8/18	24			48	24	44
253	33	8/33	24			40	56	
254	18	8/18	24			56	24	44
255	18	8/18	48	40	24	72		24
256	18	12/18	24			64	24	44
257	49	8/49	56	48	28	64		24
258	43	7/43	32			64	24	44
259	21	8/21	24			72	44	
260	39	6/39						
261	29	4/29	48	64	24	72		
262	20	6/20	40			28	44	
263	49	8/49	56	64	28	72		24
264	33	6/33						
265	21	8/21	56	40	24	72		
266	21	8/21	32			64	44	
267	27	8/27	72			32	44	
268	21	8/21	28			48	44	
269	20	8/20	64	32	40	28		24
270	27	8/27						
271	21	8/21	56			72	24	
272	21	8/21	56			64	24	
273	21	8/21	24			24	56	
274	21	8/21	56			48	44	
275	21	8/21	56			40	44	
276	21	8/21	56			32	44	
277	21	8/21	56			24	44	
278	21	8/21	56	32	48	24		
279	27	8/27	24			32	24	44
280	49	8/49						
281	21	8/21	72	24	56	24		24
282	43	8/43	86	24	24	56		
283	21	8/21	56			24	24	44
284	21	8/21	56			32	24	44
285	21	8/21	56			40	24	44
286	21	8/21	56			48	24	44
287	21	8/21	24			24	24	44
288	21	8/21	28			32	24	44
289	21	8/21	56			72	24	44
290	29	8/29						
291	15	8/15	40			48	44	
292	21	8/21	28			48	24	44
293	15	8/15	48	32	40	56		
294	21	8/21	24			48	24	44
295	15	8/15	48			32	44	
296	37	8/37						
297	33	8/33	28	48	24	56		
298	21	8/21	28			72	24	44
299	23	8/23	24			24	56	
300	15	8/15						
301	43	8/43	24			48	24	44
302	16	8/16	32			72	24	
303	15	8/15	72	24	40	48		24
304	16	8/16	24			48	44	
305	15	8/15	48			32	24	44
306	15	8/15	40			32	24	44
307	15	8/15	72	48	40	56		24
308	16	8/16	32			48	44	
309	15	8/15	40			48	24	44
310	31	8/31						
311	16	8/16	64	24	24	72		
312	39	8/39						
313	16	8/16	32			28	56	
314	16	8/16	32			24	56	
315	16	8/16	64			40	24	
316	16	8/16	64			32	44	
317	16	8/16	64			24	44	
318	16	8/16	56	28	48	24		
319	29	8/29	48	64	24	72		24
320	16	8/16						
321	16	8/16	72	24	64	24		24
322	23	8/23	32			64	24	44
323	16	8/16	64			24	24	44
324	16	8/16	64			32	24	44
325	16	8/16	64			40	24	44
326	16	8/16	32			24	24	44
327	16	8/16	32			28	24	44
328	41	8/41						
329	16	8/16	64	24	24	72		24
330	33	8/33						
331	16	8/16	64	44	24	48		24
332	16	8/16	32			48	24	44
333	18	8/18	24			72	44	
334	16	8/16	32			56	24	44
335	33	8/33	72	48	44	40		24
336	16	8/16	32			64	24	44
337	43	8/43	86	40	32	56		
338	16	8/16	32			72	24	44
339	18	8/18	24			56	44	
340	17	8/17						
341	43	8/43	86	24	32	40		
342	18	8/18	32			64	44	
343	15	8/15	40	64	24	86		24
344	43	8/43						
345	18	8/18	24			40	56	
346	18	8/18	72	56	32	64		
347	43	8/43	86	24	32	40		24
348	18	8/18	24			32	56	
349	18	8/18	72	44	24	48		
350	18	8/18	72	40	32	64		
351	18	8/18	24			24	56	
352	18	8/18	72	24	24	64		
353	18	8/18	72			56	24	
354	18	8/18	72			48	24	
355	18	8/18	72			40	24	
356	18	8/18	72			32	24	
357	18	8/18	72			24	44	
358	18	8/18	72	32	48	24		
359	43	8/43	86	48	32	100		24
360	18	8/18						

Motive power for the machines in a wood working establishment in Brooklyn is furnished by fourteen induction motors varying in capacity from 5 to 20 horse power. The majority of these motors are mounted overhead upon wooden sleepers bolted to the beams of the floor above. They require no care further than an occasional replenishing of the oil wells. Many of the motors operate in an atmosphere heavily laden with wood dust from the wood-working machinery and are completely covered with this oil-soaked dust but show no injury therefrom. The motors are belted to short line shafts which in turn drive various types of belted machinery, including turning and mounting lathes, circular and band saws, buffers, blowers, drill and machine-shop tools. The motors are started at a reduced voltage by means of starting coils and when near synchronous speed are thrown directly upon the 220 volt system. The power equipment has been in operation for over one year and has been thoroughly satisfactory in every respect.

LION TAMING.

Mr. George M. McCarthy, president of the Hudson County, N. J., Society for the Prevention of Cruelty to Animals, believes that lions come within his jurisdiction. Recently one of these animals has been taking part in a play called "The Lion's Bride" at a Jersey City theater. It was his duty to roar whenever the bride appeared because a Turkish Sultan, whose bride she would not be, had sentenced her to be eaten by the lion. The roar he emitted at sight of the girl frightened the audience, but an animal expert who saw the show informed President McCarthy that the lion's roars were caused by pain and not by anger or a desire to eat the heroine. He also said that he believed the pain was due to electricity. President McCarthy visited the theater and found that the bottom of the lion's cage, which was of iron, was connected with several electric wires that made the lion roar whenever the current was turned on. He notified the manager that the electricity must be omitted, even if the lion refused to roar without it. The order will be obeyed.—*Electrical World and Engineer.*

[Now that the electrician is knocked out in his effort to entertain the public, it remains for some enterprising mechanical genius to devise a roaring apparatus to accompany the lion in his act.—EDITOR.]

WHEREIN NEW JERSEY HAS BEEN FOREMOST.

New Jersey must be credited with influencing the industrial development of the country in other and more substantial ways than by the incorporation of gigantic combinations, by which means it is attracting attention at the present time. In the early history of the country, especially, her citizens figure prominently as leaders in scattering the seeds of future industrial growth.

The first steam engine in America was erected in 1753 at the Belleville copper mines, near Newark, N. J., by Hornblower, 16 years before Watt began his investigations.

The first steam boats driven by single and twin screw propellers were constructed by John Stevens, at Hoboken, in 1802 and 1804.

The Phœnix, the first steamboat to navigate the ocean, was designed, constructed and operated by Jerseymen—John Stevens and his son, Robt. L. Stevens, in 1807 and 1808.

The first charter for a railroad in America was granted by the Legislature of New Jersey in 1814, for a railway from Trenton to New Brunswick during the war of 1812.

The machinery of the Savannah, the first steamship to cross the ocean, was constructed at the Vail Works, Speedwell, near Morristown, N. J., in 1818.

The first locomotive in America to convey human beings on a railway track was constructed at Hoboken in 1825.

The first successful experiments with the electro-magnetic telegraph based on discoveries of Prof. Henry, of Princeton, were made by Vail & Morse, Speedwell Works, near Morristown, in 1838.

These facts were gathered by the curator of the National Museum, for the New Jersey Historical Society.

* * *

The *Engineering News* mentions a well-equipped boiler shop recently built in Alsace, Germany, in which the floor is made of clay mixed with cast iron turnings and borings, the mass being well tamped into place. In front of the workbenches pine flooring on oak joists, is laid.

THE USE OF A SURVEYING INSTRUMENT IN MACHINE SHOP PRACTICE.*

CHARLES C. TYLER.

Many machine shops now have floor surface plates upon which large work is laid out and various machining operations are performed by the use of portable machine tools secured to the plate. The quality of the work produced is largely determined by the accuracy of the laying out, the correctness of the portable tools, and the trueness of the surface plate.

For work having moderate dimensions, scales, squares, beam-compasses, and straight-edges can be purchased in the market sufficiently accurate, if used by careful workmen, to meet the average requirements in laying out the work and setting the portable tools; but for work having large dimensions the scales, squares, beam-compasses, and straight edges, become quite special, are expensive, and require the utmost care in their manipulation to insure correct work. Ten-foot steel squares and beam-compasses spanning twenty-five feet are not easy tools to make or handle, and the fear that errors might be made in some large work to be undertaken at East Pittsburg, led the writer to the consideration of doing away with these abnormal tools and substituting others more easy to manipulate and of a kind to insure accurate results.

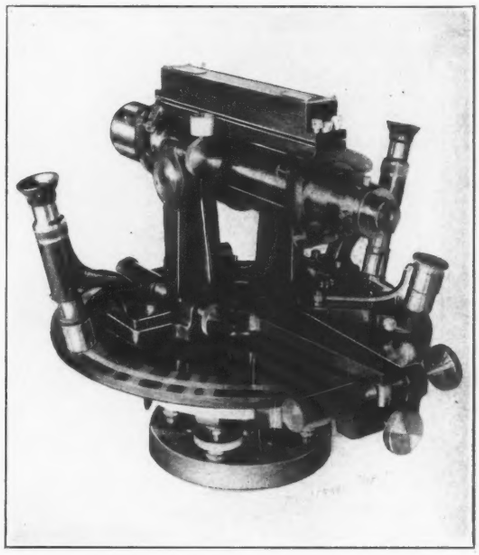


Fig. 1. Surveyor's Transit Designed by the Warner & Swasey Co. for Machine Shop Use.

To carry out the method adopted a dividing and leveling instrument was required, similar in principle to a surveyor's transit, but of special design, adapted to the needs of the machine shop in points of accuracy and convenience. The instrument in use was designed by the Warner and Swasey Co., Cleveland, O., and has a knurled base to be screwed to the cap of a tripod, or in this particular case to a supplementary base with a taper hole by which it can be readily centred on a suitably designed cast iron column which rests upon the floor plate. The knurled base of the instrument has four leveling screws by which, with the usual ball and socket joint and the use of accurate levels it can be adjusted and clamped in a level position. In the center of the instrument are two vertical spindles, one inside the other. The outer spindle carries a horizontal, graduated circle and the inner one a yoke supporting the telescope. The circle is provided with clamps and slow motions by which its O division can be brought to any position in azimuth and there clamped independently of the telescope. The graduations of the circle can be read to 1/10 degrees by two opposite microscopes.

The telescope has an objective one and one-half inches in diameter and is provided with the usual cross-hairs and focusing adjustment. The telescope rests in a cradle which can be revolved about its longitudinal or long axis and has trunnions supported by bearings in the yoke before mentioned. One

* Abstract from paper read before the December, 1902, meeting of the A. S. M. E., New York.

of the trunnions carries a slow-motion arm which can be clamped at any position for accurate altitude setting. The yoke is provided with clamps and slow motions so that the telescope can be moved to any azimuth position relatively to the graduated circle and independently of it.

To illustrate the use of the instrument, let us assume that we have a floor plate, suitable portable vertical slotters or planers, and portable horizontal drilling and milling machines, and that we are to construct a cast-iron ring of over twenty feet outside diameter, properly proportioned. This ring is to be made of six similar sections suitably cored and ribbed, and the operations to be performed are the accurate planing of the joints, cutting the keyways, and drilling the holes for the clamping bolts.

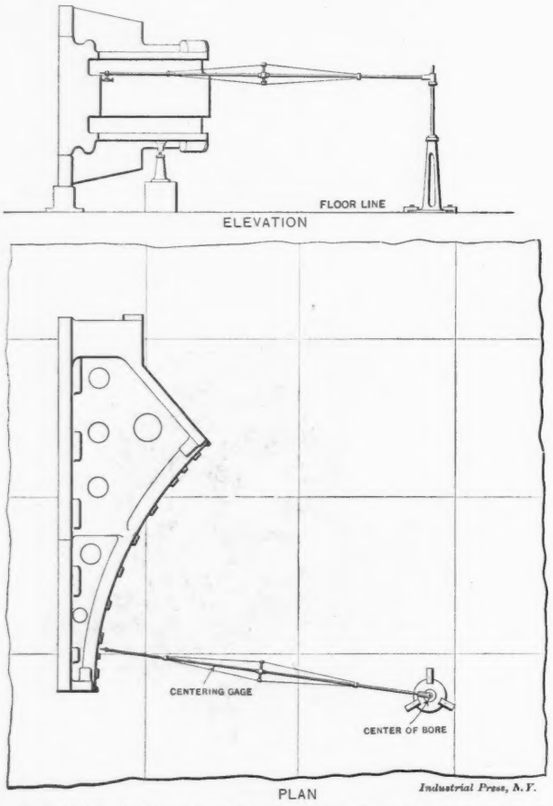


Fig. 2. Locating the Transit on the Floor Plate relative to the Large Casting.

Mount one section upon planed cast-iron blocks about two feet thick and fasten securely to the floor plate, being careful to equalize any warped surfaces found in the casting. The center column is to be moved about upon the floor plate until its exact position in relation to the section has been determined by the use of the centering gage, and the column is then to be securely fastened to the floor plate, where it should remain until all the operations upon the section have been completed. (See Fig. 2.)

Mount the dividing instrument upon the center column, and with the telescope determine the correct position for the zero division of the divided circle of the instrument, to insure equalizing the cut at each joint surface, and clamp the circle in this position. The next move is to secure a straight-edge or parallel to the floor plate in such a position that its front edge is in exact alignment with what is to be one finished joint surface. The location of the straight-edge is determined by the dividing instrument and by the use of a special target which rests upon the top of the straight-edge and has a zero line exactly in alignment with a shoulder which touches the front of the straight-edge. (See Fig. 3.) Another straight-edge is then to be secured to the floor plate under the other joint of the section, and its front edge must be set at exactly sixty degrees from the first straight-edge; its position being determined by the dividing instrument and the special target used in the previous case. The accuracy of the location of both straight-edges being demonstrated by proof surveys, we are ready for planing the joint surfaces.

Planing the Joint Surfaces.

For the joint planing operation let us use a portable vertical slotter or planer having the front edge of its base exactly parallel with the horizontal travel of the tool slide. Secure the portable slotter upon the floor plate with the front edge of its base exactly parallel to the front edge of the straight-edge; the accuracy of the setting being easily determined by a pin gage, and the fine adjustment being obtained by screw jacks bearing against the base and stop lugs inserted in the floor plate. While the roughing cuts are being made upon one joint surface, set a second portable slotter by the other straight-edge in the same manner and proceed with the roughing cuts at this end. In order that the workman may not cut beyond what should be the finished joint surface when roughing, it is advisable to scratch a finish line on the rim section at each joint, but the setting of the tool for its finishing cut is more easily and accurately made by the use of the telescope of the dividing instrument than by any other plan yet tried.

Before setting the tool for the final finishing cut it may be thought advisable to prove the surface of the last cut—a much simpler matter than at first appears. Let us suppose the last cut has left two-hundredths inch stock to be removed and that we have a target with a center line adjustable in a line parallel with one edge. By resting the edge of the target against the surface and adjusting its center line until it exactly cuts the center of the cross lines of the telescope when set at the correct angle, we can survey the joint surface and prove that it is or is not parallel with what is to be the finished

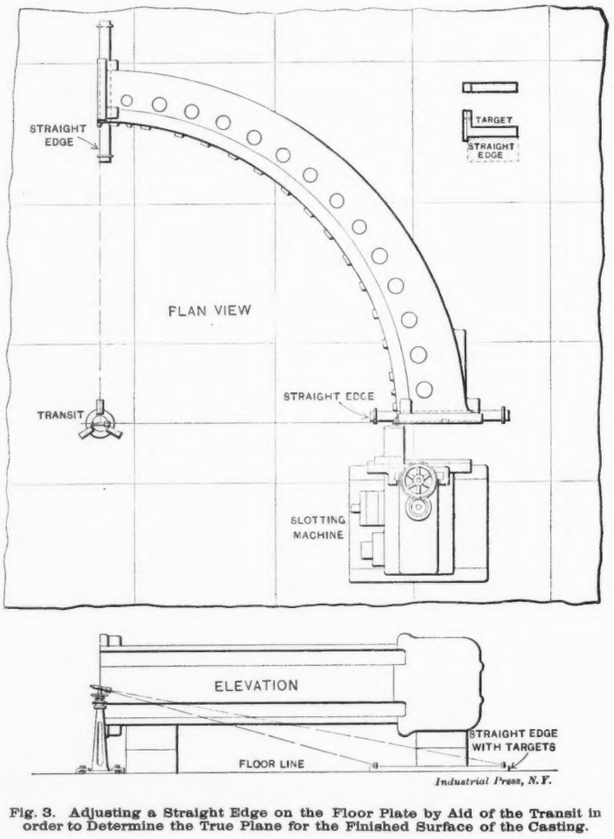


Fig. 3. Adjusting a Straight Edge on the Floor Plate by Aid of the Transit in order to Determine the True Plane for the Finished Surface of the Casting.

joint surface. If the surface be found correct, the finishing cut can be made at once; if there be an error, proper adjustment of the portable slotter must be made and the joint surface again surveyed after taking a light cut. The accuracy of the finished joint surface can easily be determined by the dividing instrument with suitable targets.

Cutting the Keyway and Drilling the Holes.

If the keyway is to be cut parallel with the face of the rim section, the operation can be performed by a portable horizontal milling machine or a portable slotter having a horizontal movement to the tool slide—the correct setting of either machine to be governed by the straight-edge attached to the

floor plate, and the exact vertical location of the keyway determined by a surface gage.

If the keyway is to be cut parallel with the axis of the rim section, the portable slotter can be used advantageously and the exact distance of the keyway from the center of the ring determined by a pin gage calibrating from the tool to a pin inserted in the taper hole of the center column.

The axes of the bolt holes should be perpendicular to the joint surface, and they can easily be made so if the front edge of the portable horizontal drilling machine be perpendicular to the travel of the spindle and the base of the machine set parallel to the straight-edges attached to the floor plate. The exact position of each hole is better determined by a jig located by the keyway and a scratched center line; but if the jig is thought too expensive, the holes can be quite easily laid out in the usual way.

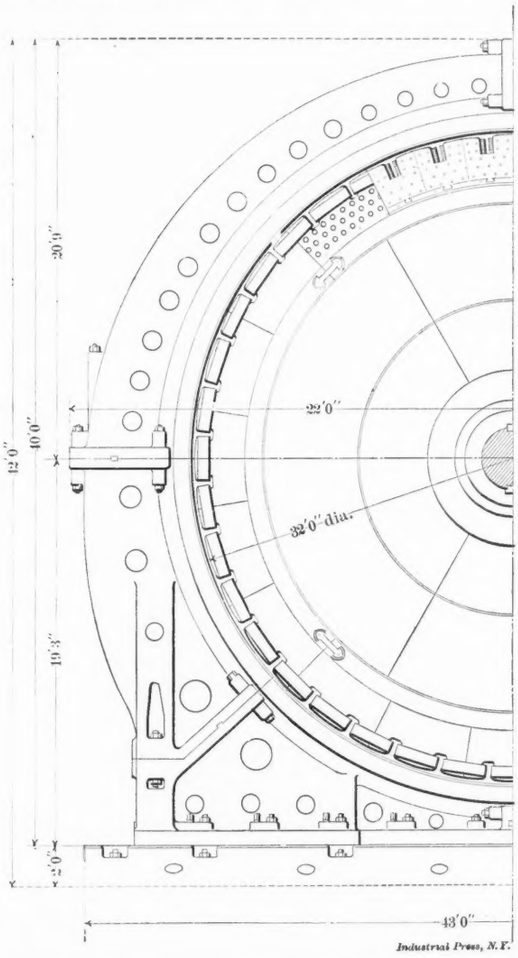


Fig. 4. Showing the Dimensions of a Large Field Frame to be Machined.

For each of the other five sections the same process should be gone through, and it will be found much easier to adjust the center column and straight-edges than to attempt to locate each section.

Testing Portable Machine Tools.

By the aid of the dividing and levelling instrument it is easy to test the accuracy of portable machine tools. In the case of a portable vertical slotter the vertical travel of the tool slide can be determined by setting the instrument so that the cross lines of the telescope exactly cut a line drawn upon the tool block when at its lowest position. Elevate the tool slide to its highest point, tip the instrument, and note the position of the line on the tool block in relation to the cross line of the telescope. If the tool travel is in a line perpendicular to the base, and the instrument has been properly levelled, there will be no variation in the reading. If the tool travel is not perpendicular, the instrument indicates the error, and correction can be made in the portable tool itself or shims can be used under the base to correct the error.

To test the parallelism of the transverse travel of the tool slide with the front edge of the base of the machine, set the front edge of the base parallel with a straight-edge secured to the floor plate in a surveyed position—one edge of the straight-edge being approximately perpendicular to the tool slide. Adjust the tool slide until it is exactly perpendicular to the straight-edge by the scratched line as determined by the telescope. A transverse movement of the tool slide to its near and far position will indicate any error; if one be found, it is best to correct the machine by planing or scraping, as may be necessary.

To test the spindle travel of a portable horizontal drilling machine, set the instrument to cut the line of a target attached to the end of the spindle, and survey the spindle in its different horizontal positions. The vertical travel of the spindle slide can be determined by locking the spindle in one position and moving the slide up and down, the same as for testing the slotter. Other portable machines can be tested by similar means, and the result of the tests can be depended upon if the instrument is accurately made and the errors in the subdivisions of the circle are known.

Practical Application of the Method.

The method described has been practically applied to some of the mechanical operations incident to the manufacture of the eight 5,000 kilowatt, alternating current, engine type, 3-phase generators built for the Manhattan Railway Company by the Westinghouse Electric and Manufacturing Company.

The approximate dimensions of some of the principal pieces of one of these generators are shown in Fig. 4. The extreme height from the bottom of the bed to the top of the yoke is 42 feet, and the greatest horizontal distance over all is 44 feet. The bed plate, 43 feet long, has two parts, securely keyed and bolted together, each 21 feet 6 inches long by 10 feet 3 inches wide by 2 feet thick.

The stationary element, or armature, has six principal sections—two lower, two middle, and two upper—all securely keyed and bolted together; the bore being 34 feet, approximately.

The revolving element, or field, consists of many pieces, the principal ones being the cast-steel hub, the two web plates of six pieces each, and the four ring sections. The diameter of this element is 27 feet 8 inches over rim sections, and 32 feet over all.

The total weight of the stationary and revolving elements of this machine (without the shaft) exceeds 1,000,000 pounds, or 500 tons. It is evident from these figures, as well as from the general design of the parts, that very careful machining was necessary and unusual provisions were required to insure success. The principal portable tools used were vertical slotters or planers having a stroke of 8 feet, a small horizontal adjustment of the tool slide, a transverse tool travel of 4 feet—the column having a horizontal adjustment of 4 feet; horizontal drilling machines having a vertical adjustment of 8 feet, the column a horizontal adjustment of 4 feet, with spindle travel of 4 feet; vertical slot milling machines, radial drills, and small vertical slotters.

The principal stationary machine tools were a 14-foot planer, 8-foot open-side planer, radial drills with 10-foot arm, 16 to 24-foot and 16 to 36-foot extension vertical boring and turning mills, 28-foot vertical boring and turning mill, 122-inch engine lathe, a special floor-boring machine carrying portable heads, and several smaller machines.

Bed Plates and Bottom Section.

The bottom and top of bed plates were planed on the 14-foot planer; the joint surface and keyway on the open-side planer, and the joint bolt holes were drilled on the floor plate with portable horizontal drilling machines.

The bottom sections were the most difficult to machine, and a more detailed description of some of the operations on these pieces will make it unnecessary to outline so fully the operations on the other sections.

By referring to Fig. 4, it will be noticed that the lower or perpendicular joint is at right angles to, and the upper joint has a portion parallel to, the bottom or base—the remainder of the upper joint being at a definite angle from the lower

joint. The rough casting was mounted on the floor plate, resting on cast-iron blocks, the bottom being set approximately perpendicular to the plate, as shown in Fig. 2.

The proper location of the section involved the making of numerous measurements to insure plenty of stock for finishing—this being particularly necessary for the slot lugs located in the bore. The center column was mounted on the floor plate and its position determined by the centering gage, as shown in Fig. 2, more or less proof testing being necessary to insure its exact location, after which it was securely clamped to the plate.

The perpendicularity of the faces of the slot lugs was determined by scribing lines upon the top surface of the slot lugs with the center gage at the proper elevation, and by lowering the center gage rest or support similar lines were scribed on the bottom surfaces of the slot lugs—scale measurements being accurate enough to prove this setting, after which the bottom section was bolted to the floor plate. The dividing instrument was then mounted upon the column, properly beveled, and finish lines scribed at each joint surface.

Straight-edges were then secured to the floor plate in their exact position—one edge of each being set exactly perpendicular to the desired finished joint surface, the position of these straight-edges being determined by the dividing instrument and a suitable target, as shown in Figs. 3 and 5.

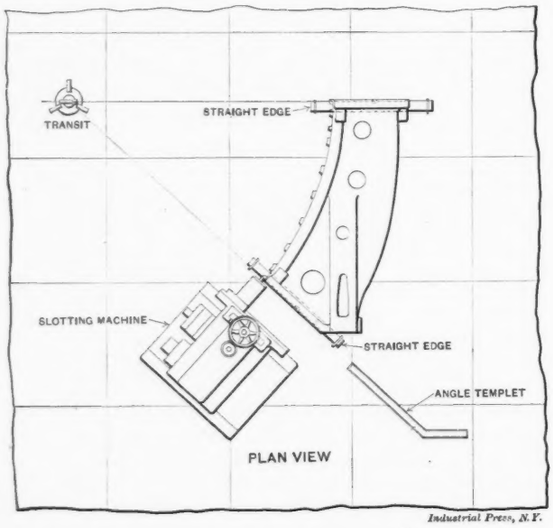


Fig. 5. Another Application of the Transit—Laying Out the Surfaces to be Planed by the Portable Shaper.

After proving the exact position of these straight-edges, the portable slotters were set in their correct location, secured to the plate, and the roughing cuts taken—slotters often working upon both joints at the same time. The accuracy of the rough planed joint surfaces was proved by the dividing instrument and an adjustable target, after which the cutting tool was set by the instrument for the final radial finishing cut. For that portion of the upper joint of this section parallel to the bottom, the slotter was set by the aid of the angle templet, shown in Fig. 5—a pin gage proving that the tool slide was parallel with the angle templet.

The joint bolt holes were drilled by portable drills, the position of the bolt holes being determined by the use of drill jigs located by keys and by a center line. The drill jigs were made reversible for drilling holes in the faces of the corresponding joint surfaces of the connection sections.

After completing the operations upon the joint surfaces, the lower sections were finished upon the bottom on a stationary planer. The next operation was the drilling of the bolt holes and the drilling and tapping of the adjusting screw holes in the bottom of the section under radial drills.

The operations upon the joint surfaces of the middle and upper sections were laid out and finished in substantially the same manner.

Large Boring Machine and Floor Plate.

The foregoing abstract covers the more important part of Mr. Tyler's paper and illustrates in a very clear manner the method followed in the use of the transit for laying out heavy machine work at the Westinghouse shops. Mr. Tyler next takes up the assembling of the various parts of the armature and field frame, showing how the alignment may be tested as the work proceeds. The frame was first erected in a vertical position on the floor plate and later re-assembled in a horizontal position on a special floor boring machine. The machine consists of a horizontal floor plate 48 feet square, at the center of which is a rotating table, level with the floor, 18 feet in diameter, which carries various tool heads. When boring large work these heads are carried on arms which have sufficient radial adjustment to bore up to 40 feet in diameter. When the frame was first assembled in a vertical position the inside horizontal and vertical diameters were measured; and then when the frame was assembled on the boring machine the same diameters were again measured to determine the extent of the deflection of the upper sections when in an upright position. It was found from the second measurements that the former vertical diameter had increased twelve-hundredths inch and that the horizontal diameter had not materially changed, showing that the deflection was mainly in a vertical direction. By numerous heavy braces and wedges the upper sections were sprung inward toward the center until the diameter corresponded with the diameter recorded during the first assembling, and the frames were then bored, faced and recessed to the required dimensions.

After the preliminary design of these large electrical machines had been determined upon, it was apparent that the buildings, traveling cranes, and machine tool equipment then in service at East Pittsburg were inadequate for the work. A new building was therefore erected, and electric traveling cranes were provided, having ample capacity and mounted on runways of sufficient height to give the crane-bridge the necessary clearance over the top of the generators.

For the operations to be performed by portable tools, and for the erection of the machines, a surface floor plate was considered a necessity, and the one provided is 48 feet wide by 176 feet long; weight, about 2,000,000 pounds. This floor plate consists of 132 cast-iron sections, each 8 feet square, of box section heavily ribbed, keyed, and bolted together—provision being made for the removal of any broken section, should such a mishap occur. The plate, well grouted, rests upon transverse brick piers 12 feet deep, built upon a solid bed of concrete, about 3 feet 6 inches thick. The brick piers are 4 feet apart, center to center, tied together at suitable distances by brick arches, and the space between the piers is filled in to within 5 feet of the under side of the cast-iron plates. The filling between the piers is covered by a layer of concrete, having enough pitch to properly drain into a longitudinal tunnel at one side of the plate. There are numerous rows of drilled and reamed holes for stop lugs, and tee slots extend the whole length of the floor plate, with numerous cored holes at the bottom of the slots to permit the chips to fall through into the transverse tunnels. The main tunnel has trap doors through which the chips can be taken out.

* * *

The American people have been prodigally wasteful of their timber resources, and now that lumber is becoming more and more expensive as the available supply decreases, means are just beginning to be employed to lengthen the life of wooden structures exposed to the weather, like telegraph poles, railroad ties, piles and similar work. Paint is, of course, of no value in preserving wood that is under ground or continually exposed to water action, as in the case of piles. The fiber must be impregnated with creosote or other chemicals of a similar preservative nature. A number of American railroads have recently installed timber preserving plants, some of which are of extensive proportions. The Great Northern Railway has a plant built by the Allis-Chalmers Co., at Flathead Lake, Montana, which has a capacity of 4,000 railroad ties per 24 hours. The three movement zinc-tannin process is used.

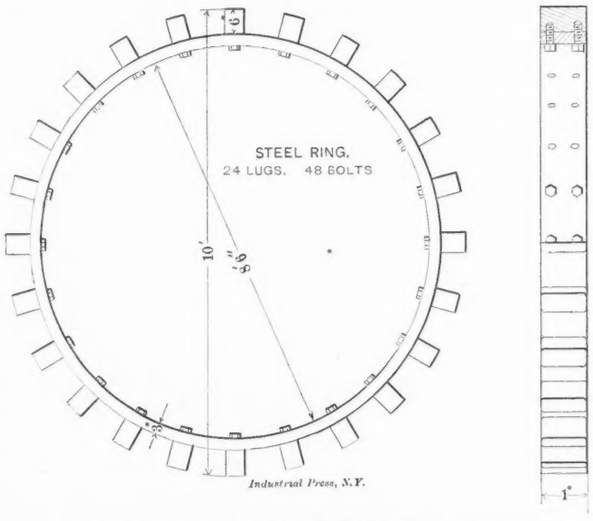
ROTATING RING WITH ATTACHED LUGS.

DESIGN WITH REGARD TO TENSION IN RING AND LUG BOLTS.

FORREST R. JONES.

The limiting speed at which a flywheel may run is generally determined by assuming the tensile stress that the material of which it is made can safely be subjected to, and then calculating either the linear velocity of the periphery, or the number of revolutions, that will cause the assumed amount of stress. In making the calculations for the limiting speed it is quite customary to deal with the rim as if it were free from the arms, thus neglecting their effect upon it. In other words, the rim is dealt with as if it were a plain ring, without attachments, lying on a horizontal table and rotating about a vertical axis coincident with that of the ring. While such an assumption neglects the pulling-in action of the arms and the consequent bending effect on the rim, as well as their tendency to reduce the pure tension in the rim, it is the best that can be applied, for the stresses as they actually exist are so complicated that they cannot be intelligibly dealt with in numerical calculations.

The ring of an electric generator that carries the lugs which form the cores of a rotating magnetic field may be dealt with for determining the tension in it in much the same manner as a flywheel. Such a ring, free from the supporting arms, is represented in the figure. The difference



Steel Ring for a Rotating Magnetic Field for Electric Generator.

between this and the flywheel rim is that the lugs cause tension in the ring in addition to that induced by its own weight and rotation, and that there are bolts passing through radial holes which cut away part of the material.

The speed of rotation that will induce a tensile stress of 14,500 pounds per square inch in the ring, and of 12,000 pounds per square inch in the lug bolts, using the form of ring and other parts shown in the figure, will be calculated. The ring is of forged steel 8 feet 6 inches internal diameter, 3 inches thick radially, and 1 foot wide. The lugs are 6 inches long radially and weigh 100 pounds each. Two lug-bolts are used to fasten each lug to the ring.

The following notation will be used:

C = centrifugal force of one lug, pounds;

$P = P' + P''$ = total tension in rotating ring due to the speed and weight of both itself and the attached lugs, pounds;

P' = total tension in the rotating ring due to its own speed and weight, pounds;

P'' = total tension, due to the speed and weight of the lugs, in the ring, pounds;

V = linear velocity of the rotating ring, feet per minute;

W = weight of the material of the ring, pounds per cubic foot;

a = effective area of bolts for resisting tension, square inches;

d = diameter of the body of the bolts used for attaching the lugs to the ring, inches;

g = 32.2 = force of gravity;

p' = tension, due to its own speed and weight, in a solid rotating ring of 1 square inch cross section;

r = distance from axis of ring to center of lugs, feet;

v = linear velocity of rotating ring at its mean radius, feet per second.

The tension in a ring that is as thin radially as the one now under consideration can be found, with sufficient accuracy for the purpose of designing, for any speed of rotation, by the following formula which gives pounds per square inch:

$$p' = \frac{W v^2}{144\, g}$$

The weight of steel forgings of this description is about 490 pounds per cubic foot. Substituting this value of W and that of g as 32.2 gives

$$p' = \frac{490\, v^2}{144 \times 32.2} = .1058\, v^2 \text{ lbs per square inch.}$$

The cross section of the ring is $3'' \times 12'' = 36$ square inches. The total tension in the ring due to its own weight is therefore

$$P' = 36 \times .1058\, v^2 = 3.81\, v^2 \text{ pounds.}$$

When the ring and lugs are rotating, a point in the middle of the length of the lug, measured radially, moves faster than one at the mean radius of the ring in the same proportion that its distance, 57 inches, from the axis of rotation is greater than the mean radius, 52.5 inches, of the ring. Therefore, the

$$\text{Mean linear velocity of lugs} = \frac{57\, v}{52.5} = 1.085\, v$$

The force necessary to prevent a lug weighing 100 pounds from the flying off the ring when both are in motion is expressed by the equation, in which v is the mean linear velocity of the ring, and r is the distance from the axis of the ring to the center of the lug,

$$C = \frac{100\,(1.085\, v)^2}{g\, r} = \frac{100 \times 1.177\, v^2}{32.2 \times 57 \div 12} = \frac{100 \times 1\,177 \times 12 v^2}{32.2 \times 57} = .772\, v^2$$

The total radial pull of the 24 lugs if distributed uniformly around the entire circumference of the ring would induce an

$$\left.\begin{array}{l}\text{Average radial pull}\\ \text{per inch of cir-}\\ \text{cumference.}\end{array}\right\} = \frac{24 \times .772\, v^2}{\text{circum. of ring}} = \frac{18.528\, v^2}{105\, \pi} = .0562\, v^2 \text{ lbs.}$$

This radial pull of the lugs exerts a bursting force upon the ring which has practically the same effect as the internal pressure of confined steam, air or water in a thin shell cylinder, and may be dealt with in the same manner for determining the tension due to it in the ring. The formula applied to this case gives for the total tension in the ring due to the lugs:

P'' = radial force per inch of circumference $\times$ radius of ring $= .0562\, v^2 \times 52\,5 = 2.96\, v^2$ lbs.

The total tension of the entire cross section of the ring is the sum of that due to the speed and weight of both the ring itself and the lugs. It is expressed by

$$P = P' + P'' = 3.81\, v^2 + 2.96\, v^2 = 6.77\, v^2 \text{ pounds.}$$

Since a part of the material of the ring is cut away by the lug bolts, it is necessary to determine their diameter as the next step in the calculations. The effective sectional area of a bolt such as will be used to hold the lugs in place is that at the bottom of the thread. Since the diameter of these bolts is not yet determined, the exact ratio of the diameter at the root of the thread to that of the body of the bolt is not exactly known. It is on the safe side to assume that the diameter of the body is 1.18 times that of the root of the thread. This is a somewhat larger ratio than actually found for ordinary bolts from 1.75″ to 3″ diameter of body. Under this assumption a bolt in tension with a body diameter d has an

$$\text{Effective area of bolt} = \frac{\pi\, d^2}{4\,(1.18)^2}$$

Two bolts are to be used for each lug. Their combined tensile strength must be equal to the centrifugal force of one lug. This centrifugal force has been determined as $C = .772\ v^2$ pounds.

The equation between the bolt area and the centrifugal force of a lug, for two bolts in each lug, at a tensile stress of 12,000 pounds per square inch in the bolt, therefore, is

$$\frac{12000 \times 2\,\pi\,d^2}{4\,(1.18)^2} = .772\ v^2$$

Whence

$$d = 1.18\ v \times \sqrt{\frac{2 \times .772}{12000\ \pi}} = .00757\ v$$

The greatest tension per square inch in the ring is where the cross section is reduced by the two bolt holes for one lug. The solid sectional area is here decreased by an amount equal to the thickness of the ring multiplied by twice the diameter of a bolt. Therefore, for a tensile stress of 14,500 pounds per square inch in the material of the ring, the following equation can be written:

$$14500 = \frac{P' + P''}{\text{Effective area of ring}} = \frac{P' + P''}{(3 \times 12) - (3 \times 2\,d)}$$

It has already been found that $P' + P'' = 6.77\ v^2$. That of d may be expressed as $.00757\ v$. By making these substitutions in the last equation, it becomes

$$14500 = \frac{6.77\ v^2}{36 - (6 \times .00757\ v)} = \frac{6.77\ v^2}{36 - .0454\ v}$$

Whence

$$v^2 + \frac{14500 \times .0454}{6.77}\ v = \frac{14500 \times 36}{6.77}$$

$$v^2 + 97.2\ v = 77500$$

This equation can be put into form for extracting the square root by adding 2360 to each side so as to make the left-hand member a complete square. Thus

$$v^2 + 97.2\ v + 2360 = 77500 + 2360.$$

And by extracting the square root

$$v + 48.6 = \sqrt{79860} = 282.5$$

$$v = 234 \text{ feet per second.}$$

Or

$$V = 14040 \text{ feet per minute.}$$

The speed of rotation corresponding to this linear velocity can be found by dividing the linear velocity by the circumference of the ring, whence

$$\text{Speed of rotation} = \frac{14040}{9\,\pi} = 500 \text{ rev. per minute.}$$

The outer diameter of the ring is here used in order to roughly balance the error introduced by using the mean diameter of the ring and the radial distance to the center of the lugs, instead of the correct slightly larger values. The reason for not using these correct values is that it is difficult to determine them, and the error introduced by the method that has been followed is very slight in this case. With a ring thicker radially, or longer lugs, the error would increase rapidly.

The diameter of the bolts may now be determined by introducing the value of v just found into the equation for d developed earlier in the solution. Thus

$$d = .00757\ v = .00757 \times 234 = 1.77 \text{ inches.}$$

A body diameter of 1.75″ would naturally be used in practice.

As a check on the work that has been done, the values of the tensions in the ring and bolts may now be determined by introducing the speed of rotation and bolt diameter that have been found.

$$\text{Net sectional area of ring} = (3 \times 12) - (3 \times 2 \times 1.75)$$
$$= 36 - 10.5 = 25.5 \text{ square inches.}$$

$$\text{Tension in ring} = \frac{P' + P''}{\text{net section}} = \frac{6.77\ v^2}{25.5}$$

$$= \frac{6.77 \times (234)^2}{25.5} = 14600 \text{ lbs. per sq. inch.}$$

A bolt of 1.75″ body diameter has, according to tables of standard threads, an area at the root of the thread equal to 1.746 square inches. Therefore the

$$\text{Bolt tension} = \frac{.772\ v^2}{2 \times 1.746} = \frac{.772 \times (234)^2}{2 \times 1.746} = 12100 \text{ lbs per sq. inch.}$$

These values of tension are slightly higher than actually induced by a speed of 500 revolutions per minute, for this speed of rotation corresponds to a linear speed of the fastest moving point in the ring only as high as was determined for v at the mean radius of the ring by calculation. By making the speed of the mean radius of the ring as high as v was determined, the peripheral velocity would be increased.

There are, of course, bending stresses in the ring due to the localization of the radial pull of the lugs at the points where they are attached; also at the points where the arms of a spider for supporting and driving the ring are attached. As has already been stated, it is practically impossible to determine these stresses. There might be a gain in some cases by making the ring thicker radially where it is pierced by bolt holes, so as to make the cross section at these points as great as between the lugs. This is generally a source of considerable additional cost.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers, which opened in New York on the evening of December second, was one of the most interesting in the history of the society; not because of the rare technical merit of the papers, nor of the great value of the discussions, but because mechanical engineers, like other human beings, enjoy a scrimmage, when it becomes animated enough to be interesting. The chief topic up for discussion was the metric system and the subject of the metric system permeated the meetings from beginning to end.

In the absence of President Reynolds, who, according to custom, should have delivered the annual address at the opening session, the first of the technical papers was read by Prof. Reeve, upon a duodecimal system of numeration. Such a system is interesting as a project, and has the advantage that its unit of 12 can be divided by 2, 4, and 3, all factors convenient to use.

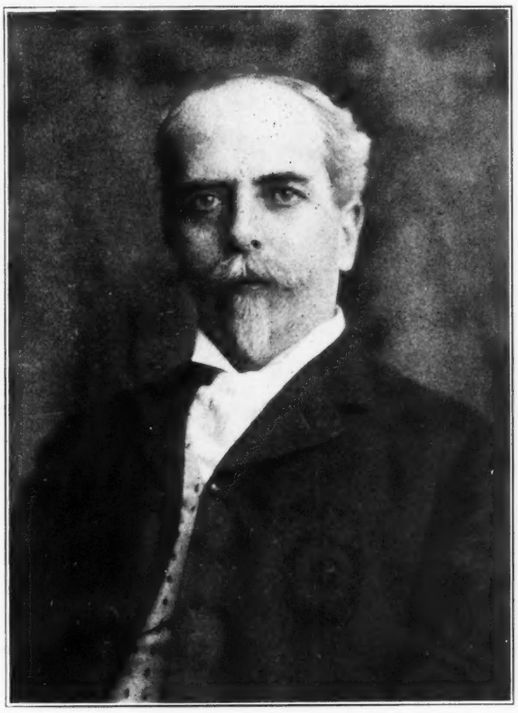
On Wednesday and thereafter the sessions were held in the assembly hall at the Sturtevant house, an arrangement that was much appreciated by the members present, for it not only abolished the annoyance of the crowded lecture hall at the society rooms, but it gave much better facilities for serving lunch on the days of the meeting. The Wednesday morning session was devoted entirely to the transaction of business, with Vice-President Waitt as chairman, who showed rare ability in parliamentary matters. The business consisted principally of the report of the council, and the appointment and reports of committees. A committee of four was appointed to serve with four members from each of the other three leading engineering societies, for the award of the John Fritz medal, and committees were also announced for the consideration of standard machine screw threads and to co-operate with committees from other societies to establish specifications for testing materials.

The Committee on Rules and Methods submitted several questions, one being that of the dues and age limit for junior members of the society. This led to an extended debate which did not clarify matters much, until finally a resolution was passed voicing the sentiment that Juniors hereafter elected should not be allowed to remain Juniors after the age of 30, but should be required to become Associate or Regular members, according to their qualifications, and pay the increased rate of dues to such membership; or else be dropped from the rolls. A resolution was also passed calling for a letter ballot of all the members in the case of a change in the constitution or rules.

At the afternoon session the metric system discussion began. Mr. F. A. Halsey presented his paper upon the subject, which was the opening gun—one of large caliber—for he presented what are perhaps the strongest arguments ever brought together in one paper in opposition to the system. He went to the bottom of the subject and brought out a great

mass of evidence to show that in the so-called metric countries, where the metric system has been used for many years, there are numerous other systems in vogue, which, by the inertia or preference of human nature, or both, will probably continue to be used by individuals and firms for years to come. He explained fully, by apt illustrations, why the same thing would happen here were the metric system to be introduced.

The heavy artillery on the other side was handled with telling effect by F. J. Miller, of the *American Machinist*, Director Stratton, of the National Bureau of Weights and Measures, and J. H. Southard, chairman of the Congressional Committee of Weights and Measures, the latter two attending the meeting and speaking by special invitation. Many letters were read for and against the system, those from Cincinnati manufacturers in particular being strongly against it.



James M. Dodge.

The discussion comes up at this time, primarily because of the bill pending before Congress to require all the departments of the government to use the metric system, and to make the system the legal standard of the country (which, by the way, it is now, so far as the measures of length are concerned). The chief objection to the bill seems to be not so much the use of the metric system by the government departments as the fear that the government may wish to make the system compulsory, and might in any case require machinery or other products sold them to have metric dimensions. That the first of these effects would be possible or the second probable was vigorously denied by Chairman Southard and he is, perhaps, in a position to give as unbiased judgment as anyone. It was contended that it would be impossible for the government to compel the use of the system outside of its own departments, and that in selling machinery practically the same conditions would hold as in supplying the metric countries at the present time, where but few if any changes in the machines are required.

The committee previously appointed by the society to consider the metric system presented a report strongly advocating the English system, and denouncing the metric system. At the time of its appointment it was known that this committee was adverse to the metric system, and for this reason it was moved that the report be laid on the table and the motion was carried.

The council was then instructed by a very close vote to confer with other societies with regard to the appointment of a committee composed of members from each, to investigate the matter further. At a later session, also, the Secretary was instructed to prepare blanks to be sent to each member for obtaining his individual opinion regarding the system—a very happy ending of the whole controversy.

Abstracts of several of the technical papers presented at the different sessions have been prepared for use elsewhere in this number and in the next number of MACHINERY.

The New President.

The new President of the society, Mr. James M. Dodge, was born June 30, 1852, at Waverly, New Jersey, on the farm of his grandfather, Prof. James J. Mapes, a noted chemist and scientist of his day. His mother is Mrs. Mary Mapes Dodge, Editor of *St. Nicholas* Magazine, the leading children's magazine. After three years at Cornell University, and one year at Rutgers College, New Jersey, at which place he took a special course in chemistry under the late Prof. George H. Cook, geologist, he served an apprenticeship at the Morgan Iron Works, New York, and spent a number of years of his earlier life at the shipyards of John Roach, Chester, Pennsylvania. Afterwards he went to Chicago and entered the employ of the Ewart Manufacturing Company in the manufacture of link-belting, in which business he has been ever since. He is now president of the Link-Belt Engineering Company, the Dodge Coal Storage Company, the Stair Lift Company of Philadelphia, and a director in a number of concerns. He has taken out considerably over one hundred patents, a number of which have proved to be commercially valuable.

* * *

COOLING RAILWAY MOTORS BY COMPRESSED AIR.

Patents have been granted to Messrs. Mailloux and Gotshall for two systems of cooling electric railway motors by means of compressed air. The size of electric motors is seriously restricted by the gage of the wheels between which the motors must be located. The compressed air cooling scheme is designed to increase the power factor for a certain size of motor which means that it could run at higher speed and develop greater power without overheating. The maximum permissible working temperature for the motor coils, is from 150 to 160 degrees and if this is exceeded the insulation soon chars and becomes defective. The efficiency of the motor also decreases with the increase of temperature. The compressed air is conveyed to the motors by pipes from the airbrake system or an independent air supply. Three systems of controlling the air flow are suggested: Hand control, in which the exhaust from the airbrakes is diverted into the motor cases instead of being allowed to escape into the atmosphere; automatic devices set to discharge air into the cases periodically; and thermostatic devices that would open the air valves when a certain temperature had been exceeded. One great advantage of the system, aside from that of increasing the motor capacity, is that it allows of electric braking. Electric braking is desirable for two reasons, but in the present overworked state of electric railway motors, is not generally feasible on account of overheating; it returns to the line a percentage of the energy required to get a car up to speed, and partly eliminates the wear of brake shoes.

* * *

While it is undoubtedly the case that kerosene oil is of a very penetrating nature and that it will leak through a very narrow crack, it is also the case that water is nearly if not quite as penetrating. One reason that leakage of water through a narrow crack is not so apparent as that of kerosene oil, is that it evaporates and leaves little or no trace of the leak. Again if there is any sediment or suspended mineral matter carried by the water, the evaporation soon leaves a deposit that effectually seals the crack and prevents further leakage. In the case of kerosene oil the leakage does not evaporate, or does so very slowly, and spreads over the outside of the vessel making its presence very apparent whereas the total leakage may be quite small. With the oil there is no tendency for a leak to seal itself, but on the contrary kerosene oil is of a highly solvent nature, and tends to remove all deposits clogging the crack.

SEMI-ROTARY STEAM AND COMPRESSED AIR HAMMER LIFTER.

E. W. Merrill, Jr., Brooklyn, N. Y., has taken up the manufacture in this country of the Brett semi-rotary drop hammer lifter, of English design, which is here illustrated. These lifters can be operated either by steam or compressed air and can be used to deliver one or a series of equal blows, or they will deliver variable light and heavy blows. These blows are of an elastic nature as the return of the hammer is instantaneous. Fifty to seventy blows per minute are ordinarily given with these lifters while at a low fall as high as one hundred blows per minute can be obtained.

Fig. 1 shows an automatic self-contained drop with a 600 pound hammer. The two levers at the right are connected by light rods to the valves controlling the throttle and the automatic trip. The lever controlling the automatic trip moves between two quadrants containing a series of notches which hold it in any desired position. When in its highest, lowest, or intermediate notch, the hammer will trip, automatically, at its corresponding high, low, or intermediate fall. The change of fall can be made in a few seconds either with the machine in operation or at rest. The drop is operated by releasing the latch with the aid of the treadle in the same manner as on a board drop, one or a repeated number of blows being given until the foot is removed. The variable light and heavy blows are obtained by operating the throttle lever as on a steam hammer.

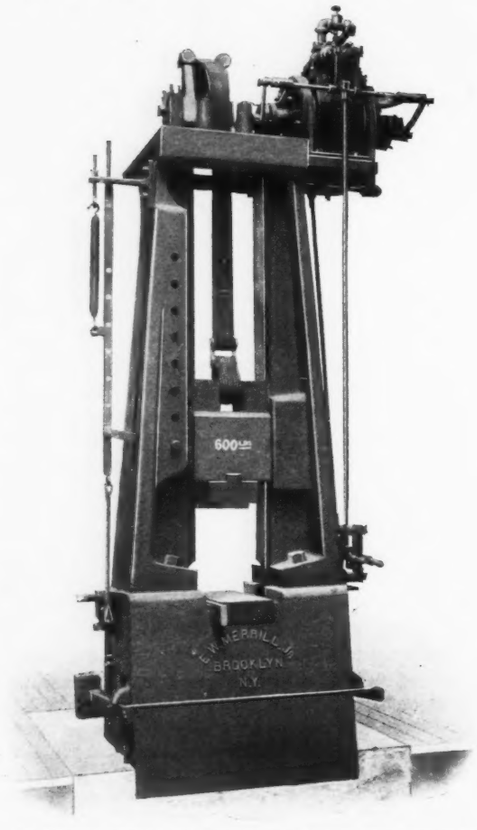


Fig. 1. Six hundred pound Drop Hammer with Merrill-Brett Hammer Lifter.

The method by which the hammer is raised will be clearly seen by reference to Fig. 2, which is a section through the cylinder with the piston, lifting arms and idler pulley in the positions which they would occupy when the hammer, which is fastened to the strap *I*, is down and at rest. In order to raise the hammer, steam enters the port A, presses against the wing B, and forces the piston to any desired position, say E. As the lifting arms F form a part of the piston shaft, when the piston revolves these arms are carried around to the position K carrying with them the strap *I*, and thus raising the hammer. When the piston has reached the position E, steam is cut off and that in the cylinder returns through the port A to the exhaust. This permits the piston to return to starting position and allows the hammer to fall. D is the division block and L the relief and safety vent.

This lifter may be applied to any style of drop hammer as the lifting mechanism can be mounted on any frame built over the hammer, or it may be located on the floor above. The scope of these machines is almost unlimited,

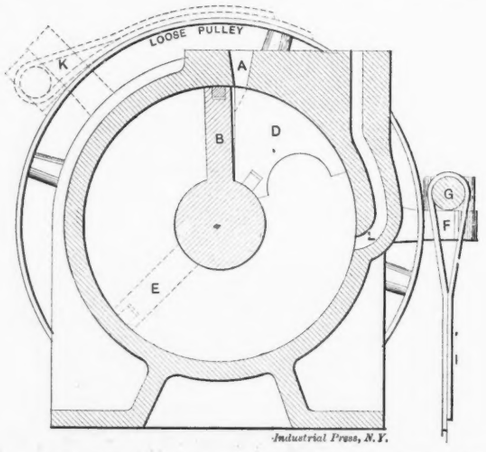


Fig. 2. Section through Piston of Merrill-Brett Drop Hammer Lifter.

drop forgings being now applied to all kinds of work. The size of work which can be handled in this way is constantly increasing, one case of recent practice being the forging, with these drop hammers, of mild steel locomotive pistons weighing 240 pounds each.

* * *

COMBINED STANDARD AND OPEN-SIDE PLANER.

In many shops there is a demand for the occasional use of an open-side planer but not enough to warrant the purchase of a machine made exclusively for that class of work, and as a standard type of planer is much better for all-round work, the occasional open-side work is done with an extension tool

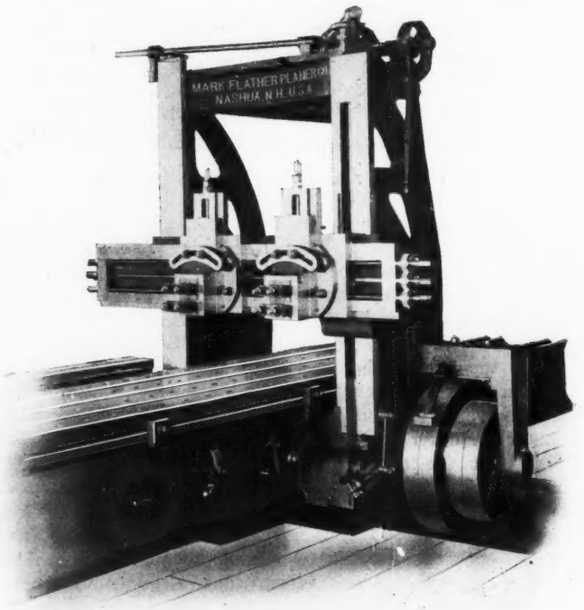


Fig. 1. Combined Planer arranged as Standard Machine.

with a great deal of trouble and expense. To supply this demand, the Mark Flather Planer Co., of Nashua, N. H., have designed and put upon the market, the combined standard and open-side planer, which is here illustrated. The cuts are made from photographs of their 42-inch standard planer changed to the open-side. As shown in the photos, the far housing can be moved back and an extension piece placed

between the cross-rail and the face of the housing. In the planer shown, the distance from the point of tool to face of housing is 63 inches, so that a piece 5 feet wide can be planed. The cross-rail, being the builder's regular standard 42-inch planer, with two heads on the rail, is long enough to square down work 63 inches wide with the far head, and by setting

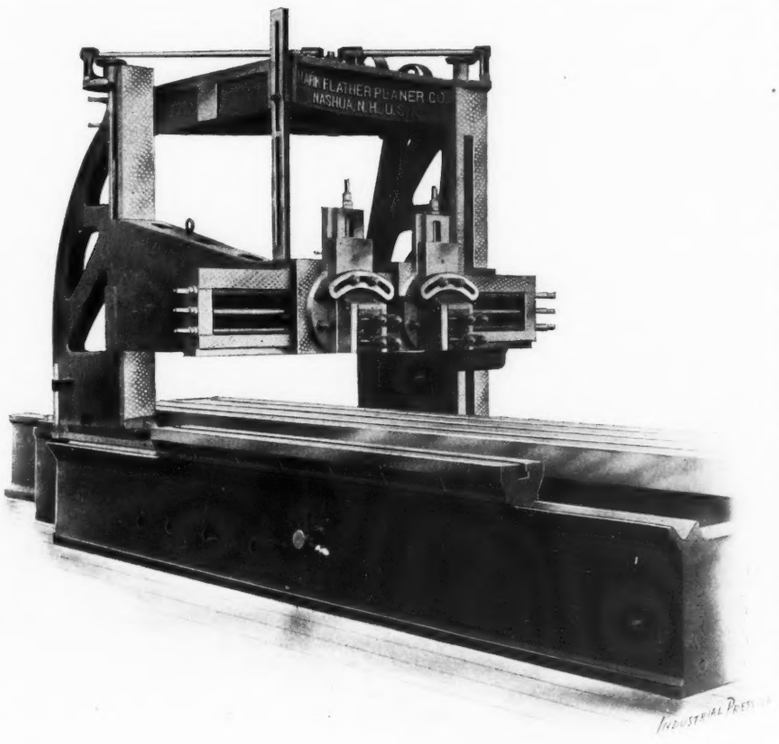


Fig. 2. Combined Planer arranged as an Open-side Planer.

the head at an angle, several inches wider can be planed. A supplementary table to support the work, slides easily in a V-way, and gives a very secure outer support to which work can be bolted. A rolling table can be furnished instead of the above, if preferred.

The far housing is tongued into the top of bed, the cheek of which is made long enough to enable the housing to be moved back the required distance, with a rack pinion, so that the extension can be put into position and bolted to the cross-rail and housing, making a very rigid support for the rail. The face of the extension is made exactly like the face of the housing and is fastened to the rail by the same means as to the housing. The back part of the extension is made to fit over the two edges of the housing as well as to the face. The nut on the raising screw is disconnected from the rail and fastened to the extension and is made in such a way that the alignment of the rail is not changed by moving the housing. The rail is made to fit over the face and both edges of housings and is extended above and below the regular width of the cross-rail on the near housing, in order to give a greater bearing and support for the rail, so that when the far housing is removed, the rail will still be held rigidly in position. The change from a standard planer can be made in a very few minutes, and reversing mechanism can be operated from either side of the planer by hand and by the shipper dogs in front.

The power raising attachment for cross-rail, as shown in the drawing, is driven by two friction pulleys, similar to those used on countershafts for lathes. The bevel pinion on this shaft drives a double bevel gear in a central position on the tie which connects the two housings, the lower and larger one is driven by the pinion on the pulley shaft and the upper drives two cross shafts. One of these is rigidly connected with the near housing and the second one with the far housing and both are made to swivel round the central driving gear and also on the raising screw of the far housing. The shaft also telescopes through the bevel gear so that moving the housing from one position to another the shaft is free to slide through the gear as it moves around the circle of the central gear. As these gears revolve around the central gear, the relative positions of the raising screws are not altered since the bevel pinions revolve around the driving gear and also the bevel gear on the screw, consequently causing no change in the position of the screws. The driving gears are all contained inside the bed, which is double webbed around the gears and makes a stiff and powerful arrangement for driving the tables.

The feeding mechanism for the heads is driven by a new relief friction which has recently been brought out by the builders and is positive in its action in moving the feeds, but when released takes no power and does not heat. The reversing motion provides for one belt doing its work, then leaving the pulley before the other starts, preventing the disagreeable squealing of belts. The machine is entirely under the control of the operator at any part of the stroke and there is no unpleasant jar or jerk when the machine is reversed. In other features this machine is essentially the same as the standard planer built by this company.

* * *

Electrical traction has been found to be most satisfactory on the Manhattan Elevated Railway. The Second and Third Avenue lines are now completely equipped and 608 electric cars are in operation. It is expected that the Sixth and Ninth Avenue Lines will be completely equipped by April 1, 1903.

* * *

Brass is primarily an alloy of copper and zinc. Ordinary yellow brass consists of

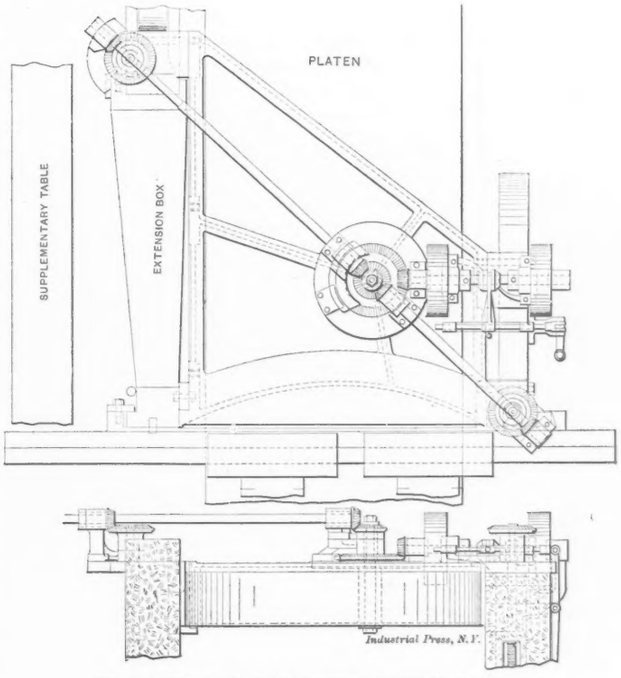


Fig. 3. Power Raising Attachment for Combined Planer.

2 parts copper to 1 of zinc. Lead is also used, a common mixture being copper 60, zinc 36, and lead 4. Bronze is an alloy of copper and tin. The standard ordnance bronze or gun metal, was formerly copper 90 and zinc 10, but the term "gun metal" is now a very elastic one. A gun metal alloy known as "steam metal" because of its common use for valves and fittings, is copper 87, tin 6, zinc 5, and lead 2.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

THE FIRST IRON BRIDGE.

After standing securely for upwards of 120 years the cast iron bridge which The Coalbrookdale Company erected over the Severn in the years 1777-1779 has failed by the sudden breaking of the girders. The structure is believed to be the first metallic bridge ever erected, and it possesses the further distinction of having given its name to the picturesquely situated riparian township of Ironbridge in Shropshire. The span of the arch is 100 feet, the width, exclusive of parapets, 26 feet, and the height from base-line to center, 40 feet, while the weight of iron in the bridge is about 380 tons. No details are at present available as to the cause of fracture, but it is surmised that "fatigue," due to long-continued vibration, may have some connection with the collapse. Cast iron for bridge building is no longer in favor, rolled iron or steel being the material generally used, but for all that, there are few wrought iron or steel structures now being erected that are likely to remain intact for such a prolonged period as has the famous cast iron bridge over the Severn.—*Ironmonger.*

FLOATING FIRE TRAPS.

The passenger steamers plying Long Island Sound are widely known as the most palatial inland-water boats afloat. The cabins and upper decks appear surprisingly spacious to one accustomed to the river or lake boats in other sections of the country. The upper works of the boats, however, while magnificent in appearance, are in reality mere tinder boxes, built with thin pine partitions. In the advent of a fire having a few minutes' start this inflammable material would be consumed in a much shorter time than it would take to tell the story. In 1888 the Fall River steamer *Bristol* burned while at the Newport wharf and although she was favorably located for fighting the fire and for the escape of the passengers, it was with the greatest difficulty that loss of life was prevented. Not profiting by this experience, the Fall River line has recently ordered another "floating palace," which, like its predecessors, will also be a floating fire trap. If it was impossible for the passengers and crew to escape from the comparatively slow-burning ocean-going steamers which were destroyed by fire at the Hoboken docks of the North German Lloyd line two years ago, how would it be in the case of a crowded Sound steamer a mile or two from land?

ANOTHER TOOL STEEL.

Another high-speed tool steel is said to have been produced by a new process at the Bismarck Furnace, in Silesia, Germany. The new material is claimed to greatly exceed in cuting power even the tool steel made by the Taylor-White process, and to have the added advantage that it will work successfully with much smaller cuts than the latter material. Thus it may be used on ordinary machine tools to increase their efficiency, whereas the Taylor-White steel can only develop its full efficiency on specially strong and powerful machines. This information is taken from the *Engineering News* which quotes the following from a German technical paper: "A certain steel shaft of hard steel (tensile strength 78,000 pounds per square inch) was given a cut of .024 inch with a feed of .12 inch. Using ordinary tool steel it took about 280 minutes to cover the surface of the shaft (about 775 square inches); with Taylor-White steel it took 140 minutes, whereas a tool made of the new material did the work in about one hour. It is stated that in working soft steel, with the new tool steel, taking a fine finishing cut, a peripheral velocity of 5½ feet per second could be reached, while other tool steels could not be made to cut at all at this speed."

FROM THE TECHNICAL SCHOOLS.

A short time ago we published an item regarding the new electrical laboratory of the Massachusetts Institute of Technology, Boston, which has been designed especially for research in the electrical field and has the equipment necessary for carrying on experiments similar to the advanced work conducted at the best German universities. These facilities for advanced study are now to be extended to other departments of the Institute, and beginning with the new year arrangements will be completed for several post-graduate courses, leading to the degree of Doctor of Engineering. To attain this degree students must be graduates of a technical school, or otherwise equipped for advanced work, and must carry on extended researches along original lines. They will be subjected to rigid examinations by the faculty, and in each case the degree will be conferred because of work completed rather than as an honorary degree frequently given to distinguished men by universities.

Another press dispatch of interest relative to educational matters is that several millions of dollars will be expended by the University of Chicago in establishing a technological department. It is expected that buildings for the new school will be begun next autumn and will cost, together with the equipment, at least $3,000,000.

ELECTRIC TRUCK FOR MACHINERY TRANSPORTATION.

In New York City the Niles-Bement-Pond Co. have taken the initiative among machinery dealers, by purchasing an electrically-driven truck built by the Vehicle Equipment Co., which concern is represented by the Rainier Co., 393 Broadway, New York. This truck is for use in New York city, and has a number of novel features. It has what is known as the pedestal running gear, the pedestal being a single steel casting fastened to the frame of the vehicle. The axle bearings are located in jaws in this pedestal and have absolute freedom vertically, but none laterally. The battery is below the wagon body, leaving the latter entirely clear, and is made of sectional trays which slide out at either side. The power is furnished by General Electric motors operating independently on the rear wheels. The tires are of 6-inch solid rubber. The controller has four speeds ahead and two for backing, and the battery has a radius of 25 miles on a single charge. The maximum speed of the truck is 5½ miles an hour. An electrical windlass is placed forward, under the seat, for loading freight, and is operated by an independent motor and controller.

A TEN-TON STEAM TRUCK.

This question of the use of motor trucks for the transportation either of raw materials or finished products is one that is being considered by many manufacturers. A few months ago we illustrated the details of the Morgan steam truck, manufactured by the Morgan Motor Co., of Worcester, Mass. Since then this company has brought out a 10-ton truck which is one of the most powerful automobiles ever constructed. It has a total length of over 22 feet and a width of 7 feet. A water-tube boiler is used, with burners using either fuel oil or kerosene. The engine is a double tandem compound, and the truck can always be started without reversing. Where unusual power is required live steam can be admitted to the low-pressure cylinders. There are two sets of driving gears, one in the ratio of 10 to 1, and the other of 20 to 1. The rear wheels, which do the driving, are fitted with steel tires, giving two inches of tire surface for every ton of load carried. The pulling strain of the engines is taken off from the rear springs by struts, which are braced against the supporting I-beams. The throttle is so made that when the lever is pulled back from the center, steam is admitted to the engine, but when the lever is thrown ahead of the center steam is admitted to a cylinder which actuates the brakes, and if for any reason they should fail to work the machine can be stopped by reversing the engine. On each end of an intermediate shaft connected with the engine is a capstan, and it is possible to throw the engine out of gear with the main transmission, so that it acts only on the shafts bearing these capstans. It is stated that by the use of these and of a hawser attached to a near-by tree or telegraph pole the machine can be pulled out of almost any difficulty and

even backed down into the excavation and brought out again under its own power. There is also a crane on each side of the truck, by which the latter can be loaded or unloaded, heavy articles being picked up from the level of the ground. Another interesting feature planned by Mr. Morgan is to provide a truck with two or more bodies, which can be separated from the truck and loaded independently of it, thus saving the time usually lost in loading and unloading. The scheme would be to provide loading platforms in such a way that one truck body could be temporarily suspended for loading, while the truck backed against a second platform where the loaded body would be picked up and transported to its destination for unloading.

WIRELESS TELEGRAPHY.

As we go to press, dispatches announce the successful transmission of wireless messages by the Marconi system between the stations at Cape Breton, Canada, and Cornwall, England. While the transmission of these messages is apparently veiled in secrecy and may lead to some skepticism in the matter, there seems to be as good reason for believing the report as otherwise. In this connection the suits in this country now pending against the De Forest Wireless Telegraph Co., are of considerable interest, as the latter hold that Marconi is in no sense the inventor of wireless telegraphy. There have been a series of legal proceedings between the two companies. Among the claims of the De Forest Company is the one that the alleged inventions covered by Marconi patents were previously patented in England and the United States—the first being granted to Loomis as early as 1872, and one of the others in 1876 having been granted to Edison. It is also claimed that Marconi's patents were described in several papers in different countries before their date of issuance. By the De Forest system, messages can be sent at about the same speed as with any telegraphic system in which wires are used, 50 words a minute being possible; whereas it is said that 12 per minute is the greatest number that Marconi has succeeded in sending. However valuable the improvements in the De Forest system may be, we believe that Marconi will receive credit in the estimation of the public for persistently working upon wireless telegraphy until he succeeded in establishing its importance; and particularly since he himself does not claim complete originality, but admits that he has simply applied principles that have been understood by scientists for many years.

THE ECONOMY OF ELECTRIC TRANSMISSION.

In a paper, "Electricity in Railroad Shops," read before the November, 1902, meeting of the Central Railway Club, Mr. L. R. Pomeroy said that mere economy of power transmission by means of electricity as compared to other methods, is one of the least reasons for its adoption. The cost of fuel used to run the machinery of a manufacturing plant, is not usually over 3 per cent. of the cost of the article produced, labor and other items in which time is a factor representing about 47 per cent. and the material the remaining 50 per cent. But the obvious economy of electrical transmission is worthy of serious consideration. The friction load of line shafting remains constant, load or no load, while the transmission loss with electricity is always a percentage of the actual power used. If no power is being taken off by the machines, there is no transmission loss. The friction load of line shafting varies from 20 per cent. to 75 or 80 per cent. of the total power developed, and even more. It has been seriously stated that in a large cotton mill where the conditions were probably very unfavorable, as little as 1 per cent. of the power of the engine is applied to the cotton itself, the remaining 99 per cent. going into friction loss. The chief gain in machine shops, however, with electrical power transmission, is in the increased efficiency of the men and machines. In the matter of removing the wheels from a ten-wheel locomotive an electric crane will do in ten minutes what would require four men eight hours with common screw jacks, and four men one hour with pneumatic or hydraulic jacks. A list of 46 railroad shops was quoted in the paper, that have equipped with electricity or that are expected to do so in the near future.

SOLIDIFIED PETROLEUM FUEL.

A demonstration of the characteristics of a solidified petroleum fuel was given in Chicago recently, which apparently showed that the inventor, Mr. Austin Granville, has succeeded in overcoming the objectionable features that have hitherto accompanied solidified petroleum fuels made by other processes. The heat value of the briquettes is about 18,000 B. T. U. per pound, and they burn with a fierce white flame, leaving little or no ashes. The heat is so intense that for many purposes it is advisable to use coal dust, sawdust or other refuse of a carbonaceous nature to reduce the intensity of the flame. For steam making the preferable method of burning the briquettes is on a traveling chain grate, the air being admitted over the top and none through the grate. A plant having a capacity of 1,000 tons per day is being erected at Port Arthur, Texas, and another at San Raphael, California. The fuel can be delivered at tidewater from the Texas field at a cost of $1.20 per ton which, considering its greater calorific value, is equivalent to coal at about 90 cents per ton. The dangers attending crude oil in bulk are of so grave a nature that it is not probable that it can ever be used for many purposes where it would if the danger of fire was not so great. With the solidified product, however, the fire hazard disappears; also the difficulty of handling and transportation.

THE SUBMARINE BOAT.

A vast amount of money has been expended in this country upon the development of the submarine boat. From the time the United States *Housatonic* was destroyed by the Confederate submarine boat *David*, a great deal of attention has been paid to craft for navigating beneath the surface of the water, and, up to recently, the greatest progress has been made in France. But little public attention was drawn to the matter in this country until the creation of the first Holland submarine boat during the Spanish war. Mr. Holland has worked on the problem for many years and there is now a plant at New Suffolk, L. I., where there are several boats under construction for the United States Government. Recently experiments were conducted upon the two boats *Adder* and *Moccasin*, built at the above plant under the direction of a Government Board. The trials included a large number of runs—submerged, awash and floating on the surface of the water. The boats exceeded the contract speed, which called for seven knots per hour awash, eight knots per hour on the surface, and 5 knots submerged. For use when submerged there is an electric motor of 70 horse power, with storage batteries; while for running on the surface, gasoline engines are employed. The boat is fitted with tanks for compressed air, to provide fresh air for the crew; and a ventilating apparatus had to be devised, particularly since obnoxious gases are given out by the storage battery. The compressed air is also used for emptying water tanks when it is desired to shift the ballast. One of the chief difficulties in the operation of a submarine boat is its control in both vertical and horizontal planes. Apparently, these new boats can be as easily directed in one plane as in the other. It is generally admitted that the radius of action of submarine boats is not sufficient to enable them to operate at a great distance from the shore; but submarine propulsion has been so far improved that there is a good possibility of the submarine boat meeting with success in harbor and coast defense. It will at least have the effect of making an enemy uneasy.

DETERIORATION OF STEEL CAUSED BY "INTERNAL WEAR."

Iron and Machinery World. December, 1902, p. 19.

Charles H. Fitch in the course of an article on the deterioration of steel from internal wear, says that a boiler plate punch, especially a small punch, used to punch thick plates, soon loses its elastic strength. It may be as hard as ever it was, but some time it seems to break like glass. Now if we regard that bit of steel first and last as merely a hard solid body, the changes in that body will always remain blind mysteries. But if we recognize it in all its hardness and solidity as being what it is in fact—a collection of interwoven particles working together—then we can see how it is worn out by the interaction of these

particles. This little punch which at the start will go through steel nearly as hard as itself, at the finish will break like glass because it is internally worn out. Though solid it is just as truly a spring as any spiral coil over a railway axle box. When it strikes the skin of the steel, which it pierces, it is driven back like a spring until the force of that spring's compression gives it power to drive through the steel. In going through a thick plate it may vibrate several times. It is in fact a spring battering ram, a little power machine. It has, therefore, the movement and friction of a power machine, and like a power machine it wears out. Then it breaks, not from some mysterious chemical re-formation of particles, not from anything like the crystallization which attends the passage of some bodies from the liquid to the solid state, but simply because it is internally worn out, and needs to be returned to the cupola or the melting pot to be made over from the inside.

MILLING CUTTERS WITH UNDERCUT TEETH.

Abstract from paper read by S. N. Brayshaw before the Manchester Association of Engineers, October 25, 1902.

A turning or planing tool for iron or steel has top rake, as well as clearance below, and milling cutters for many operations should have similar rake. A cutter, 3 inches diameter, 1¼ inch wide, with 10 teeth undercut 10 deg., was used on steel shafting in the works of L. Gardner & Sons, Ltd., the speed being 28 revolutions per minute, and the feed 1 inch per minute, with 9-16-inch depth of cut. This gives an approximate cutting speed of 27 feet per minute, and a feed of .036-inch per revolution. At this rate the cutter left a beautifully finished surface. It ran easily, and kept its edge well. It must not be assumed, however, that undercut teeth are necessarily advantageous. Frequently they are the reverse. Mr. E. G. Herbert, of Manchester, has recently made a series of tests with three cutters 6⅝ inches diameter, 9-32-inch thick, with 1 inch hole. In each case there were 30 teeth, which in one cutter were radial and in the other two were undercut 10 deg. and 15 deg. respectively. The cutters running at 20 revolutions per minute, or a cutting speed of 42 feet per minute, were fed separately into the vertical faces of heavy blocks, first of cast iron, and then of mild steel, until the machine stopped. The feeds varied from 1.4-inch per minute to .16 inch per minute, and there was no perceptible slip of the feed belt. The results of the tests were somewhat complicated, and the curves plotted therefrom were full of interest, but they failed to show any decided advantage of one tooth over another. The general indication seemed to be that the advantage rested with the undercut teeth with a big feed, and the radial teeth gave better results with a fine feed.

WELDING LOCOMOTIVE FRAMES IN SITU.

Railway and Engineering Review. December 6, 1902. P. 876.

Most practical railroad men are familiar with the process of straightening locomotive frames, *in situ*, that have been slightly bent by wrecks or other accidents, but there are few who would attempt to make a weld under such conditions. It appears, however, that where the use of liquid fuel is well understood, it is quite practicable to do this seemingly impossible job. A large number of broken locomotive frames have been welded in position at the West Oakland shops of the Southern Pacific Ry., 56 in all, and out of this number only five have since broken in the welds and this is attributed to the welds having been made at night when it was difficult to gage the heat. The first weld was made November 11, 1899, and the frame is still in service.

The plan followed is to strip the engine at the location of the break and to build up around the frame a temporary furnace of firebrick, after the plan usually followed when straightening bent frames. The furnace is built on a piece of sheet iron so that the whole affair can be quickly dropped into the pit when the welding heat has been reached. In practice, however, the first "setting up" blows are delivered before the furnace is torn down. Thus if the break is in a frame jaw, the lower end is driven up by a heavy pneumatic hammer weighing 30 or 40 pounds; if the break is in the top rail the tail piece is struck with a 1,000-pound ram a few times, with the furnace in place. Before the heat is taken it is the practice to jack the broken ends apart and to insert a piece of end-grain iron which is allowed to project all around about ¾ inch. This is, of course chipped off after the weld is made. The oil burner works under an air pressure of about 100 pounds. Kerosene, distillates or the lighter crude oils are found satisfactory fuels for this purpose. A 23 degree gravity crude oil is frequently used at the West Oakland shops with good success. It is stated that the adjustment of the burner as to the relative proportions of air and oil, is quite a delicate operation; also that the distance of the burner from the surface of the metal, the angle of the deflection and the location of the furnace bricks around the weld, are important. Considerable practice on the part of the smith is necessary to make satisfactory welds of this description, which is quite believable. It is recommended that preliminary experiments be made with bars of iron, iron axles, etc., before trying to weld a frame.

HEAVY STEAM PIPING.

New York Meeting Engine Builders' Association, Dec. 1-2, 1902.

At the last meeting of the Engine Builders' Association of the United States Mr. William Andrews read a paper upon "High-pressure Steam Piping," from which the following notes are taken:

"Up to the year 1900 the almost universal design for a piping system for power plants was to carry a pipe for each boiler into a large steam header, whose cross section was equal to the sum of all the areas of the feeding pipes. If the designing engineer wanted to be very grand he made it larger without knowing just why. From this header, pipes were carried to the various engines, of sizes called for by the engine builder. It was quite common to place steam separators in each line leading to an engine, but fashions change in steam piping, as well as in clothes, and with the advent of high-pressure and superheated steam, sizes of pipes have been very much reduced. In the four large power houses now built in New York city, with an ultimate capacity of from 60,000 to 100,000 horse power each, the largest steam mains are not over 20 inches in diameter, and these are used more as equalizing pipes or storage reservoirs. Some of our best plants have pipes which run from the header to the engine two sizes smaller than that called for by the engine builders. These pipes, before reaching the engine, are carried into a wrought-iron or steel receiver, which acts also as a separator. This receiver has a cubical capacity three times that of the high-pressure cylinder, and is placed as near as possible to the cylinder. The pipe from the receiver to the cylinder is of the full size called for by the engine builder. The object of this arrangement is, first to have a full supply of steam close to the throttle; second, to provide a cushion near the engine on which the blow caused by the cut-off in the steam chest may be spent, thereby preventing vibrations from being transmitted through the piping system, and, third, to produce a steady and rapid flow of steam in one direction only, by having a small pipe leading into the receiver. This steam flows rapidly enough to make good the loss caused during the first quarter of the stroke. Plants fitted up in this way are successfully running where the drop in steam pressure is not greater than 4 pounds, although the engines are 500 feet away from the boilers.

As to quality of material, in the earlier days of electric light and railroad plants, owing to the difficulty of keeping the screwed joints tight, some engineers tried flanged cast-iron pipe for steam mains, but it was heavy and clumsy and sometimes cracked on account of the unequal expansion. Then came copper, and this pipe, even when reinforced with steel wire wound around it, was found to be a treacherous metal. Flanged cast-steel pipe was tried, but the difficulty of obtaining this free from blow-holes barred it out. At present the material used is either wrought-steel or wrought-iron pipe, on which the flanges are either riveted, screwed or welded. In England and on the Continent they weld a light flange to the end of the pipe and face it; it is pulled together when in use by a heavy steel or cast-iron flange, which has previously

been slipped over the pipe, very much as copper joints are made in marine piping.

In 1880 the New York Steam Co. installed about six miles of steam mains under the streets of the city of New York for power and heating purposes. All the joints in this pipe above 8 inches in diameter were made by expanding the pipe into recesses in the flanges, and then beading the ends of the pipe over the edges of the flanges. This was done by machinery, and was well done, and at the time was considered a great improvement over threading or riveting, but in five years every joint had to be taken out on account of leaks and threaded joints were substituted. These threaded joints lasted until 1895, when all the pipes were renewed with new mains having heavy wrought-steel flanges welded on the pipe. These welded flanges when turned true in the lathe make the most workmanlike and perfect steam joints in use at the present time, and their cost alone prevents their general use.

Corrugated-copper gaskets placed inside the bolts and well pulled up will make a joint which will last as long as the fittings. The softer gaskets containing rubber, asbestos, or lead alloys need constant attention, and when superheat is used they are rapidly destroyed. When the owner's bank account is strong enough ground joints without any gaskets are used. This makes a first-class job, but the price is all but prohibitive.

RESISTANCE OF AIR TO THE MOVEMENT OF FLYWHEELS.

Zeitschrift des Vereines Deutscher Ingenieure. 1902.

It has been ascertained by Herr Scholter, Manager of the Nuremberg-Further Trainways, that the resistance of flywheels is very far from being a negligible quantity. This resistance may be divided into two parts; that exerted by the friction of the air against the rim and that due to the displacement of the air by the arms; the latter being by far the more important of the two.

In the central station of the trainway there are two horizontal, tandem compound engines developing 450 horse power at a speed of 95 revolutions per minute. Each has a strong flywheel whose arms are formed of a double T with a central web set parallel to the center line of the shaft. The rotation of these flywheels produces a strong current of air which seemed to indicate the existence of a considerable resistance.

The suggestion was made to cover the two faces with a smooth protection of sheet metal, which was done. In order to determine the difference in the resistance under the two conditions, with and without the covering, one dynamo was made to serve as a motor to drive the unloaded engine. With the flywheel in its original condition, the work required was 13,300 watts, while, after the wheel was covered, only 9,874 watts were needed; a difference of 3,426 watts or about 5.7 horse power. The cost is then estimated, which may be reduced to American standards as follows:

Considering the engine to be running 17 hours per day for 365 days in the year on a consumption of 2 pounds of coal per horse power hour; the coal burned for the development of the power to overcome flywheel resistance will be about 35 tons, which at $2.00 per ton will be $70.00 per year. As the cost of covering the flywheels is an insignificant amount, the figures given above may be taken to represent a net annual saving.

As long ago as 1888 Prof. Brauer, of Darmstadt, called attention to the advisability of filling in the space between the arms of flywheels and cited an experiment made by Inglis on a 630 horse power engine in which indicator cards showed a saving of 30 horse power or 4.8 per cent. due to a reduction of flywheel resistances.—G. L. F.

FLYWHEEL EXPLOSIONS AND THEIR CAUSE.

Monthly Bulletin Fidelity and Casualty Co.. December, 1902.

W. H. Boehm has received a letter from a cotton mill owner in which he says that his engineer has made a careful inspection of the flywheel driving his mill, and has reported that there are no defects or "buggers" in it. From this report the mill owner concludes that the wheel is safe and that danger from bursting is negligible. Mr. Boehm points out that flywheels do not often break from faults of construction or material, but from a sudden increase of speed due to some accident. Most flywheels that fail are really sound and safe under ordinary conditions. The fact that a defective wheel may run for years and then suddenly burst, shows that the immediate cause was not the defects, but some change from the normal condition under which the wheel had been running.

Wheels do not often fail from torsional stress or from twisting action in pulling their load, because enough material can be put in the wheel to resist successfully any load required of the engine. There is, however, no possible way to overcome the centrifugal force due to speed. Increasing the thickness of the rim of the wheel does not strengthen it so far as centrifugal force is concerned, because the weight added also increases the centrifugal force, leaving the wheel no stronger than before. There is, therefore, a definite speed at which any wheel, however sound, will explode, regardless of the amount of material it contains. For cast iron wheels sound theory borne out by good practice has fixed *a mile a minute* as the danger limit for the rim speed. Most wheels are run at or near this speed. The normal speed, however, is only of incidental consideration, as an accident may at any moment allow the speed to get beyond the normal. As the stress in the rim due to centrifugal force increases with the *square of the speed*, disruption quickly follows even a slight increase in speed. If the speed should be accidentally tripled, for example, the stress in the rim would become *nine times* as great as before, and the wheel would have exploded long before it had attained that speed. It is here that the "bugger" gets in his awful work.

In the case of the accident at the Amoskeag Cotton Mills, he got into the governor of the engine. Although he increased the speed only 20 per cent., the flywheel burst, wrecked the mill and killed two women and one man outright. In the case of the accident at the Griffin Manufacturing Co. a year ago, the "bugger" dropped a small washer in the port of the high-pressure cylinder, causing the slight increase in speed that precipitated a flywheel wreck in which the mill and an adjoining building were partially demolished.

As a matter of fact, the percentage of flywheels that explode is 33 per cent. greater than the percentage of boilers that explode, and the "bugger," by getting into the mechanism of the engine, is directly responsible for most of the trouble.

BRIQUETTING FINE ORES AND FLUE DUST.

Abstract from Paper read before the Engineers' Society of Western Pennsylvania, by Henry S. Mould.

It is well known that in blast furnace operations metallic flue dust exists and that on this account there is a large loss to furnace owners. The scarcity and value of lump ore and the consequent necessity for using large quantities of fine material in the furnace increase the flue dust loss and give rise to other dangers and evils that sometimes entail heavy property loss and even the loss of human life.

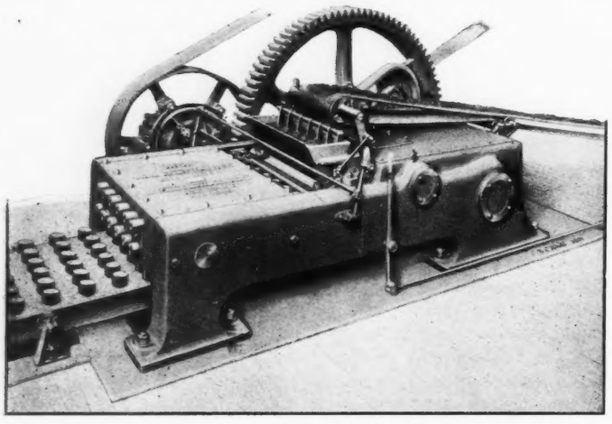
It is to do away with these evils that briquetting this fine material has been resorted to, and progress has been made only through a long succession of failures, owing mainly to the difficulty in constructing suitable machinery, and the high cost of the bond. Conditions vary widely in different regions and with the materials that are to be put into block form. The bonding agent that can be successfully used with precious metal concentrates or flue dust from the smelters cannot be successfully used with anthracite culm, and the binder used in briquetting the latter cannot be used in briquetting iron flue dust or fine ores. Adjustability of pressure is also essential, as different materials require varying pressure, ranging from 2,000 to 18,000 pounds to the square inch.

About 1895 the most available machine for briquetting was what is known as an "eggette" machine, which is composed of two large rolls, each having an indentation in its face similar in shape to half an egg, so placed as to register accurately and so designed as to allow the eggette thus formed to drop onto a conveyor or belt. While the briquettes manufactured by this process were strong enough to stand up in

the furnace, there were a number of other difficulties that made further experiment necessary before a successful process could be evolved. In the first place, using the "eggette" type of press, so large a percentage of binder was necessary that the cost of briquettes was too high. In addition to this, the machine as then constructed would not stand the wear essential in that class of work.

One of the more successful of the earlier machines was the White mineral press. This was of the disk type, the briquettes being formed in 48 molds, all in one piece known as the disk. It was found, however, that the briquettes were not hard enough to stand the pressure in the furnace without first drying; that special auxiliary machinery was required and that the cost for repairs was excessive. The gritty nature of the flue dust acted as coarse sand-paper or emery on the molds and necessitated the frequent purchase of new disks. The disks could not be re-ground or renewed; it took three men nearly half a day to replace one; a new disk weighed 1,500 pounds, was five feet in diameter, and cost about $150. This heavy repair cost feature had to be eliminated.

The second machine, patented in 1898, which was believed would do away with the faults shown by the mineral press, was an entirely new type. Instead of a disk arrangement to carry the molds to the point where the pressure was exerted, there were six molds placed in a reciprocating press-box, into which spring and compression plungers were thrust, capable of exerting enormous pressure. These molds are



No. 1. White Briquetting Press, Capacity 100 tons in ten hours.

simple in design and can be removed and replaced at a nominal cost. As they sustained all of the wear, this did away with the enormous repair cost essential where an expensive disk was used.

A testing plant was fitted up, one of the plunger type presses was installed there and the experimenting went on for three years. Binder after binder was tested and careful records of each experiment were kept. During this time, the process of briquetting in a number of fields was perfected but the successful handling of iron flue dust was still beyond the grasp of the experimenters.

A little over a year ago another testing plant was fitted up, complete in every detail, with heating and drying apparatus so as to show the process of briquetting any fine material. The plunger press had been improved in many small details, although the principle of the machine remained the same. At last a binder was discovered that would hold iron flue dust, iron concentrates, or fine iron ores in hard and satisfactory briquettes, but it took 12 hours to dry them. After a little more experiment and investigation the point was reached where a binder and drying apparatus were perfected that gave a continuous process for the briquettes from the flue dust bins to the finished briquette in cars or storage bins, the whole operation taking approximately half an hour, and these are now used in the so-called Mould process.

In attempting to briquette the flue dust it was found that the solution of the problem was much more difficult than that of the handling of fines at precious metal smelting works. One main reason was the fact that the tiny particles of iron flue dust as they are whirled about by the blast are rounded until each particle, when seen through the microscope, appears as round as a marble. In addition to this, each little piece of ore is covered with a greasy carbon coating which seems to counteract the effect of a binder. For these reasons, it has been difficult to find a binder that would give a briquette with all the essential conditions. The difficulties may perhaps be better realized when it is known that the requirements call for a briquette that shall be hard and durable; waterproof; low in moisture; able to stand long transportation in open cars; not unduly refractory or liable to decrepitate or become dust again; and the binding agent must not injure either the lining of the furnace or the quality of the iron produced.

Many striking illustrations of the possibilities of briquetting processes can be derived from the statistics of ore production. In a blast furnace producing 600 tons of iron a day, the furnace burden approximates 540 tons of coke, 375 tons of limestone, and 1,085 tons of ore; a total of approximately 2,000 tons. Assuming that the furnace managers use 80 per cent. of Mesabi ore, or 868 tons, and lose 8 per cent. of the Mesabi burden in flue dust (and these are under the actual figures if anything) what does this mean in dollars and cents? It means that every 24 hours the furnace owners are absolutely throwing away 70 tons of ore. Estimating the value of Mesabi ore in Pittsburg at $3.50 per ton, this means that the loss in flue dust alone is $245 per day or $89,425 per year.

And this is not all. There are even greater things that can be accomplished by briquetting. In 1901 the total shipment of ore from the Lake Superior region was 20,589,237 tons, and of this the Pittsburg district received about 11,000,000 tons, of which about 44 per cent., or 4,840,000 tons came from the Mesabi range alone. Exact and careful analysis of ore cargoes, however, shows that the ores carry a heavy percentage of moisture. In 1901, from a tabulated list of these analyses compiled by the ore agents of the big steel companies, it was determined that the average amount of moisture in the Mesabi output from 52 mines for the year was 10.57 per cent. In other words, the manufacturers of iron and steel in the Pittsburg district are hauling from Lake Superior, and paying freight on 511,588 tons of water. The freight rate from the Mesabi range to Pittsburg is $2.35 a ton. On this basis, Pittsburg manufacturers are paying $1,202,231 a year for hauling water from the mines. With the use of briquetting machinery, this waste in freight can be saved to the manufacturers. It is quite possible to briquette the fine ores at the mines. After first drying the material by driving off the moisture and then pressing the fine ore into blocks, the raw material can be brought direct to the furnaces in this district as lump ore, in briquettes that are waterproof and that are abundantly able to withstand the rough usage inevitable in transportation. By this means all of the evils that must now be contended with, arising from the use of fine ores, can be absolutely done away with.

CONTINUOUS CURRENT MOTORS FOR MACHINE TOOLS.

Abstract from Paper read by F. O. Blackwell before the American Institute of Electrical Engineers. November 21, 1902.

Planers, slotters, milling cutters and many other tools need only a slight variation in speed, as the relation between the tool and its work is always the same, variation in speed only being required for different classes of work—that is, for hard or soft metal or for a roughing or a finishing cut. Such work does not require more than a 2 to 1 variation, while on the other hand, lathes, boring mills and other rotating tools may require an 8 to 10 or even 40 to 1 variation, necessitated by the varying diameters of the work. For instance, take a lathe in which is being turned a shaft six inches in diameter, to obtain a cutting speed of 50 feet per minute, it will require approximately 32 revolutions per minute of the main spindle, while if the flange of a 48-inch wheel was being turned, it would require only four revolutions per minute of the spindle to obtain the same cutting speed.

The common method in use for attaining variable speed by means of the electric drive, are rheostatic, field and multiple voltage control.

Rheostatic control is obtained by introducing resistance in series with the armature of an electric motor, the speed being reduced in proportion to the power consumed in the resistance. Therefore, if a constant horse power is desired at the tool, a motor when running at reduced speeds receives a reduced potential and requires an increased current. For example: If a motor is running at one-half its normal speed it receives but one-half the line potential and requires double current. From this it will be seen that as the rheostat is consuming practically one-half the power applied, the efficiency of the combination is less than 50 per cent. This method of control is undesirable, not only on account of its being very inefficient, but also from the fact that as the load decreases the speed increases; and should a man be working on a piece of material where the cut takes only part of a revolution, the speed will immediately increase, as the tool leaves the work, to such an extent that in all probability the tool will be burned or perhaps broken when it enters the work again.

By varying the current flowing in the field coils of the motor the strength of the magnetic field is changed, and the speed of the motor varied. With any setting of the field, however, the motor will give constant speed under changes of load, and this method therefore avoids the greatest objection of rheostatic control. A motor of ordinary design will not always permit of any considerable weakening of the field without sparking at the commutator; but with a motor having small armature reaction a variation in speed of 2 to 1 can readily be obtained, and when delivering a constant horse power the current will be approximately the same at all speeds, because the potential across the armature terminals is always the same. As the field current of a motor is only a small fraction of the total current, the efficiency of this method of control is practically the same at minimum and maximum speeds; it also allows the use of a much smaller controller and renders it possible to get a greater number of running speeds than can be economically arranged for with any other control.

Multiple-voltage control is obtained by having several different line potentials to work from. For instance, with the Edison three-wire system the potential from the neutral to the outside wires is one-half the potential between the outside wires. There are, therefore, two potentials available, and a motor connected between the neutral and one outside wire would run at one-half the speed it would when connected across the outside wires. A four-wire system may also be used in the same manner, giving various combinations of potentials, the minimum of which may be about one-fourth or one-sixth of the maximum potential.

Either of the above methods combined with the field control of the motor makes a very flexible system. For example, a motor having 100 per cent. field control used on the three-wire system will give a speed variation of 4 to 1, or a motor having 35 per cent. field control used on a four-wire system with potentials of 60, 80, 110, 140, 190 and 250 volts will give a speed variation of approximately 6 to 1, or with potentials of 40, 80, 130, 170, 210 and 250 an 8 to 1 speed variation, the gaps in speed between the various potentials being filled in by field control of the motor.

It has been demonstrated many times that it takes practically a constant horse power to remove a given amount of metal per minute, irrespective of the rotative speed of the tool. Therefore, the main spindle of a lathe taking a ⅜-inch cut on a 6-inch steel shaft with a feed of ⅛-inch and a cutting speed of fifty feet per minute makes 32 revolutions per minute, and takes a certain horse power to drive which we will assume to be 15 horse power, and the motor will be working on its highest potential or 250 volts. Now, if we are using the multi-voltage system with the last-named potentials above, and should put a 48-inch wheel in this same lathe and turn up its rim with the same cut, feed and cutting speed, the main spindle would run at about four revolutions per minute or one-eighth of the previous speed, but still require 15 horse power to drive. With this condition the driving motor would have to run on its lowest potential or 40 volts, and would be consuming fully six times the amount of current it did previously. A motor to be used on the multi-voltage system will have to be sufficiently large to carry its maximum horse power at the minimum potential, or, in other words, at, say, 40 volts on a 250-voltage system, the motor will have to be six times too large when working on its maximum potential. For this reason it is desirable that we keep the lowest potential employed as high as possible in order that the size and cost of the motor may be within reasonable limits. A potential of 40 or 60 volts requires such large conductors, if they are laid out for a small drop, that their cost is prohibitive in a plant of any size. If a large drop is used, the motor falls off in speed under load and its speed regulation under changes of load is little better than with the rheostatic control.

With the three-wire system and a 100 per cent. variation in the motor speed by field control, we can obtain a 4 to 1 total variation which, for general machine-shop work, is sufficient to cover a single operation on a given tool. The total range, however, on a tool can be increased greatly by having a few gear changes. For example, on a back-geared lathe with a gear ratio of 4 to 1 a total variation of 16 to 1 can be obtained. In the same manner on a double-geared lathe a variation of 64 to 1 might be obtained.

The reduction effected by different sets of back-gears on machine tools will be found to vary from 4 to 1 to 6 to 1. All tools can be arranged with 4 to 1 changes between back-gears without any difficulty. In many cases a single back-gear is sufficient for a tool. By putting a magnetic clutch on this back-gear and making the electrical connections in the controller, it is possible to get a 16 to 1 variation electrically and without increasing the cost of the motor more than would be required for a 4 to 1 variation.

With electrical control a man can keep his hand on the controller and his eyes on the tool, increasing the speed from time to time. Being limited only by the temperature of the tool, it has been found that much higher cutting speeds are unconsciously attained with a motor-driven tool than would be thought possible were any fixed rule followed. It is therefore apparent that this increased production in many cases is so great as to fully justify the installation of an electric system, even if there were no other advantages to be secured.

In conclusion, the author gave it as his opinion that it will generally be found best to use motors with field control, allowing a total speed variation of 2 to 1 with the two-wire system or 4 to 1 with the three-wire system, believing that the four-wire system is too expensive for general application if the plants employing it are properly designed and equipped with large enough electrical apparatus. For reciprocating tools a two-wire system will meet all requirements, and there are very few rotating tools where it is not better to mechanically vary the speed for all speed variations greater than 4 to 1.

The most important consideration in the electric driving of machine tools is to make the control of the tool as convenient as possible and arrange the system so as to permit small changes in speed, and consequently be able to always drive the tool at its highest possible speed and greatest output.

NEW OIL TESTING MACHINE AND SOME OF ITS RESULTS.

Abstract of paper read at the Annual Meeting of the A. S. M. E.

In this paper Mr. Albert Kingsbury describes a machine built by him for the purpose of making comparative tests of various kinds and grades of oils. There are two important properties in lubricating oils and greases on which their value depends—viscosity and body. Viscosity is the property by virtue of which the lubricants form comparatively thick films between rubbing surfaces, permitting perfect lubrication. The effect of the lubricant in reducing friction depends mainly upon the "body" or "oiliness."

The nature of this property, or combination of properties, is not well understood, but it appears probable that it is an intensified viscosity in that part of the fluid within the region of attraction of the surface molecules of the metal.

Experiments have shown that the effects of body and of viscosity are in nearly all respects diametrically opposite, and

that it must necessarily be very difficult to derive reliable information regarding the lubricating values of oils from friction tests in which the effects of viscosity and those of body are not separately recognizable. Under this consideration, methods of testing which are described in this paper are arranged with special reference to the conditions under which the effects of either property may be investigated independently of the effects of the other.

In the machine with which these tests were made, the test journal has its axis vertical; it is suspended from the spindle by means of a flexible coupling and runs between two opposed bearings in a cylindrical cup or case, which may be filled with the oil to be tested if a "bath" is desired. The load on the bearings is provided, by means of a helical spring of 900 pounds capacity, with screw adjustment and with a device for quick application or removal of the load without disturbing the adjustment. In testing, the suspended parts turn freely to a position where the torsion of the suspension wire balances the friction at the test journal; and the angle of torsion, which may be as great as 270 degrees, is read from a graduated disk. The cup and the test journal contained in it may be heated as desired by a Bunsen flame. The revolutions of the journal are indicated by a counting device.

For tests involving perfect lubrication (friction due to viscosity only), the test journal used is 1⅜ inches in diameter, of tool steel, hardened, ground and polished. The brasses are sectors cut from a ring finished in the lathe, each having an arc of about 120 degrees and a length of 2 inches.

A number of curves have been plotted from tests made with this machine which seem to verify the deduction that the friction is proportional to the viscosity of the oil, and they also show the friction to vary roughly as the square root of the speed.

For tests for comparing oils with respect to body or oiliness the best results have been obtained by the use of a hardened and polished steel journal ¼ inch in diameter, running between two brass bearings about 1 inch long; on this small journal pressures up to 8,000 pounds per square inch may be applied if necessary. In making these tests the oil giving the less friction is assumed to have the greater body. The writer has not found the order of body values, as determined by this method, to vary with the speed or the pressure within a considerable range. A speed of 50 to 100 revolutions (3 to 6 feet per minute), with sufficient pressure to make the coefficient of friction only as great as .01 to .03, have been found most satisfactory; the pressures being from 500 to 5,000 pounds per square inch, according to the character of the oils.

The results of this method of testing for body agree thoroughly with the principal fact hitherto established with regard to body as distinguished from viscosity—namely, that the mineral oils as a class have much less body than the animal and vegetable oils. For example, in a body test of the mineral oil and the lard oil having viscosities 98.9 and 83.7 respectively, as determined by the Dudley pipette, the lard oil, although the less viscous, gives very decided evidence of greater body, by its much smaller friction. On the other hand, certain cylinder oils, wholly or largely mineral, and greatly exceeding lard oil in viscosity have also greater body than lard oil.

FLYWHEEL CAPACITY FOR ENGINE-DRIVEN ALTERNATORS.

Abstract of paper read at the Annual Meeting of the A. S. M. E.

Mr. Walter I. Slichter presented a paper which was written with the object of showing certain considerations which must be borne in mind when selecting a steam engine to drive an alternating current generator which is to run in multiple with another generator or which is to generate power for a system in which synchronous apparatus such as synchronous motors or rotary converters are to operate.

In a comprehensive manner he discussed the mechanical action of the engine when direct connected to the alternating current generator and also the allowable fluctuations in speed. A displacement of phase in the electric current of 2½ degrees from the mean will cause a cross current of about 10 per cent. of full load current to flow. This value has been more or less generally adopted by the builders of electrical machinery as the limit of displacement, if satisfactory running is to be expected. To determine a weight of flywheel which would limit the displacement to a value approximately equal to 2½ degrees the following formula has been determined, based on the unbalancing factors with a reasonable increase to allow for overloads:

$$W r^2 = \frac{K W \times C \times 10^9}{S^4}$$

where W = effective weight of wheel, KW = rating of generator, S = speed of engine in R. P. M., r = radius of gyration, C = a constant as follows:

	Horizontal Single-crank.	Vertical Cross-compound.	Horizontal Cross-compound.
25 cycles	315	275	250
40 "	505	440	400
50 "	630	550	500
60 "	755	660	600
125 "	1575	1380	1250

While not always giving the most desirable flywheel capacity, since it would be impossible to take into account all the irregularities of some engines, yet it gives a value suited to the various conditions (such as frequency of alternator, style of engine, etc.), such that if the engine is reasonably good we will get the results desired. If this weight of flywheel does not give satisfactory results it would be much better (for the electrical circuit) to make such changes in the engine itself as to give a better crank effort diagram than to increase the weight of flywheel, for a flywheel may easily give trouble by being too heavy.

As changes in the engine, the following are suggested:

First, as best though most difficult, changing the angle between the two cranks.

Second, changing the proportion of load taken by the different cylinders, and make the low pressure take more load.

Third, introduce compression at the end of the stroke to take up inertia, particularly in low-pressure cylinder.

* * *

TWO NOTABLE SPECIAL NUMBERS.

The November 6th issue of the *American Machinist* and the November issue of *Cassier's Magazine*, are notable examples of the special number scheme in trade journalism. The *American Machinist* special number was issued in commemoration of its twenty-fifth anniversary and is, of course, largely given over to an interesting historical review of mechanical progress that has taken place during its lifetime. The leading articles were contributed by men who have become eminent in various branches of engineering.

The November issue of *Cassier's Magazine* is a machine shop number, being entirely devoted to articles on various phases of this subject. There are 272 pages of reading matter and illustrations, and about 200 pages of advertising. Among the articles we note: The Multiplication of Cutting Tools by Joseph Horner, Electric Power in the Machine Shop by W. M. McFarland, Portable Machine Tools by Forrest R. Jones, Limit Gages in the Machine Shop by Wm. H. Booth, etc. It is needless for us to say that both of these special numbers are of great interest and worthy of the attention of every progressive mechanic.

A writer in the *Foundry* says that an alloy discovered by accident, which resists the action of strong sulphuric and hydrochloric acids, hot or cold, and which is only partially dissolved by hot nitric acid, has the following composition: Lead, 66.89; copper, 11.32; tin, 10.52; antimony, 3.70; iron, 0.75; silicon, 2.09, and sulphur, 0.53. We assume that parts and not percentages, are meant since the sum total is not 100. In general it seems best to give such formulas in percentages since typographical and copying errors in the figures may then be readily discovered.

* * *

In the notice given in the December issue of the death of Frederick Alfred Krupp, an obvious error was made in the statement of building property area covered by the Krupp Works in 1890. Instead of 11,700 acres, it should have been 117 acres.

PINS AND PIN MACHINES.

EXTRACT FROM UNITED STATES CENSUS REPORT, 1900.

The invention of the process of wire drawing marked the beginning of the modern pin manufacture. The process originated in France and Germany, and for two centuries these countries monopolized all industries dependent upon it. The first man to manufacture brass pins in England was John Tilsby, who, in 1626, established a plant in Gloucestershire, where he met with remarkable success, and his make of pins became famous. By 1636 the industry was so well established that the pin makers of London formed a corporation, and the trade soon found its way to Bristol and Birmingham, where, in connection with other ironwork manufacture, the industry became localized. In those cities pins were made for some time by hand labor. About 1800 William Bundy invented a method of heading pins which was the modern process in embryo.

In 1812 Bradbury and Weaver conceived the idea of heading "by means of an automatic machine." After the shanks were pointed and the heads prepared they were put into separate hoppers, where a mechanical device placed the shank and head into relation with each other. In this position the pins were pressed by screws against dies, which made the head and bound it to the shank, when they were withdrawn by hooks operated upon by parallels worked by the machine.

In 1817 Seth Hunt invented a machine to make the pin with head, shaft, and point from one piece, but his invention was not a success. In 1824 W. L. Wright, an American, a native of New Hampshire, invented the solid-headed pin-making machine, which entirely revolutionized the pin manufacture. He did not have his machine patented in America, but took it to England and put it into operation. He formed in London a company with a large capital, and built a good-sized factory in Lambeth. A plant was fitted up at great expense with 60 machines, but they were never put into successful operation, as they failed in pointing the pin. Although Wright remedied this defect by a supplemental machine, the company did not succeed, and suspended operations with a great loss to those interested in the enterprise. Fortunately, in the readjustment of the company's affairs the machinery fell into the hands of D. F. Taylor, who, by interesting capitalists in the enterprise, brought about the formation of a company known as D. F. Taylor & Co., which in 1833 put upon the market the first machine-made solid-headed pins sold anywhere in the world.

As early as 1812 the inventors of this country were using their energies to construct a machine for the manufacture of pins. The first machine made here, which was brought out by Moses L. Morse, of Boston, Mass., some time during the war of 1812, proved too delicate and intricate to be used to much advantage and was soon abandoned. The man who did more than any other individual to place the manufacture of pins by automatic machinery on a practical and successful basis in this country was Dr. J. I. Howe. In 1830 he began his labor in this direction, spending some of his time in Europe studying the methods employed there, and by the year 1832 he had patented in this country, France, and England, a machine designed to make pins similar to the English diamond pins, with heads formed of coils of small wire fastened upon the shank by pressure between dies. He brought the business to a successful issue in 1836, when the Howe Manufacturing Company was formed in New York and began operations at Birmingham, Conn. At first automatic spun-head machines were used, but in 1840 they were converted into solid-headed machines. These latter machines at first made from 40 to 50 pins per minute. They were later improved so that they made from 60 to 70 per minute.

About 1835 Samuel Slocum, an American, obtained a patent in England for a machine to make solid-headed pins. In 1838 he began with this machine the manufacture of pins in Poughkeepsie, N. Y. As he never had the machine patented here, it was operated secretly for a number of years. Until 1842 the industry made little progress because of discriminating tariffs. In this year, however, a new tariff law went into effect which was more favorable to this industry than the previous tariff act, and the above-named companies did a very profitable business. Led by exaggerated ideas which became prevalent as to the extent of the business and the profit made in it, many persons in different parts of the country invented machinery for the construction of pins. Attempts in this direction met with varying success but the articles turned out were, with a few exceptions, inferior, and the market became overstocked. In consequence of this over-production, by 1848 all parties engaged in pin making, except the two old companies at Poughkeepsie and Birmingham, suspended operation. In the year 1850 there were four establishments engaged in this industry, and the success attending them led to further improvements in the machines. A Mr. Fowler and a Mr. Atwood perfected machines to make 160 to 170 pins a minute which, on account of their capacity, soon replaced the early machines.

Following the successful introduction of a machine for making the pins, the next important step was to invent a machine that would stick them on paper. Howe and Slocum gave their attention to this matter as early as 1840. Dr. Howe invented the device for crimping the paper, and this was followed by the distributer of Mr. Slocum. The two inventions were combined and effected a great increase in the number of pins that could be stuck on a paper in a day. These devices were improved upon by Mr. De Grasse Fowler, who invented the "goose neck" or "runway." For many years the sticking machines consisted of a combination of these three devices, but more recently machines of various styles have come into use that will stick from 500 to 600 packages a day, far more than the early combined machine of Howe, Slocum, and Fowler.

The old process of pin manufacture by manual labor was very slow and tedious, since each pin passed through the hands of from 14 to 18 individuals. The modern pin is made in the United States by the improved Atwood or Fowler machines. The process of pin manufacture by modern machines may be briefly described as follows: Coils of wire are placed upon a reel, whence the wire is drawn automatically by a pair of pincers between fixed studs that straighten it. A pin length is then seized by a pair of lateral jaws, from which a portion of the wire is left projecting, when a snaphead die advances and partially shapes the head. The blank is then released and pushed forward about one-twentieth of an inch, when the head is given another squeeze by the same die. By this repetition of the motion the head is completed and the blank is cut off the wire in the length desired. About one-eighth of an inch of wire is required to make a pin head. If the attempt were made to upset this with a head in one motion the wire would be more likely to double up than to thicken as desired.

The headed blanks then drop into a receptacle and arrange themselves in the line of a slot formed by two inclined and bevel-edged bars. The opening between the bars is just large enough to permit the shank of the pin to fall through, so that the pins are suspended in a row along the slot. When the blanks reach the lower end of the inclined bar in their suspended position they are seized between two parts of the machine and passed along, rotating as they move, in front of a cylindrical cutter, with sharp grooves on its surface, that points the pins. They are then thrown from the machine properly shaped, and if they are brass pins they are cleaned by being boiled in weak, sour beer. After they are cleaned they are coated with tin. This is done by placing alternate layers of pins and grain tin in a copper can and adding water, along with some bitartrate of potash. Heat applied to this produces a solution of tin which is deposited on the surface of the pins. The pins are then taken from this solution and brightened by being shaken in a revolving barrel of bran or sawdust. Lastly the operation of "papering" takes place. This process is performed now by an automatic papering machine something in the following manner: The pins to be stuck are placed in a hopper, in connection with which a steel plate is used, with longitudinal slits corresponding to the number of pins which form a row in the paper. The pins in the hopper are stirred up by a comb-like tool, the shanks drop through the slits in the steel plate, and the pins are suspended by their heads. Long narrow sheets of paper are presented by the operator to the action of the machine, by which two raised folds are crimped, and the row of pins collected in the slit steel plate is then, by being subjected to the same action, pressed through the two crimped folds. These operations are repeated until the requisite rows of pins are stuck in each paper.

LETTERS UPON PRACTICAL SUBJECTS.

A SUGGESTION TO THE APPRENTICE.

Editor MACHINERY:

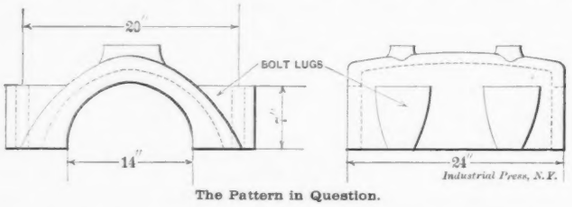
I wish to make a simple suggestion to the apprentice, which, if followed, will be sure to be appreciated in after years. It is an almost daily occurrence to hear old journeymen, during the noon hour, discussing their various tools, where they were purchased and what they paid for them. During one of these discussions one of the men was noticed to be the center of interest among his shop mates. He had traveled over the United States and the Old Country quite extensively and one of the men asked him some questions concerning some of the places which he had visited. He took from his tool chest a small note book which contained notes from the time that he started to learn his trade, each place in which he had worked, the name of the firm, location, superintendent, general foreman, etc. Also the date of entering and leaving the place, the wages received, tools purchased, where, when, and their cost. It was interesting to see the men gather around him and ask him to read some of the notes from this book.

Nothing would please me more than to have one of these books of my own but it is a little late in life to start now, so I will suggest to the young man starting out, that he keep a note book in his tool chest. MACHINIST.

HOW SHOULD THIS PATTERN BE MADE?

Editor MACHINERY:

Considerable discussion has taken place in our shop regarding the way in which the pattern shown in the sketch should be made. When I came to work in this shop my first job was to make a pattern of a cap for a 14-inch journal box. The principal dimensions of this cap are given in the drawing and it will be seen that while the inside is semicircular the outside is elliptical. After carefully studying the drawing I decided to saw around the elliptical outside, leaving as little hand work as possible, afterwards sawing out the bolt lugs



The Pattern in Question.

and fitting them to the cap. One of the patternmakers thought that this was wrong, in fact was not in keeping with good patternmaking. He contends that the lugs should have been worked from the solid and claims that all patterns previously made in this shop have been made in this way. Small bearing caps are, of course, often made from the solid but it seems to me that for making so large a cap my method was the better. I wish that some of my fellow craftsmen would give their ideas on this subject.

PATTERNMAKER.

ONE OF KRUPP'S ECONOMIES.

Editor MACHINERY:

The recent death of Frederick Alfred Krupp reminds me of some of the things I have been told by a German mechanic who worked in the great Krupp works at Essen in his younger days. At that time, of course, Alfred Krupp was in authority.

One of the economies then practiced, was of such a novel character that I will describe it so far as I know. At that time muzzle-loading cannon were being made. They were bored from solid forgings, leaving the breech solid with the rest of the gun. Instead of boring them out in the ordinary way and converting all the metal removed into chips, a solid core was taken out and afterward converted into an axle or similar forging. The boring tool was similar to a long hollow mill, and cut an annular groove in the gun to the required depth of bore. This in itself seems like an incredible operation, but the cutting off of the core at the breech seems still more so. That it was accomplished without serious difficulty, I was assured by my German friend. How the tool was constructed he could not or would not tell.

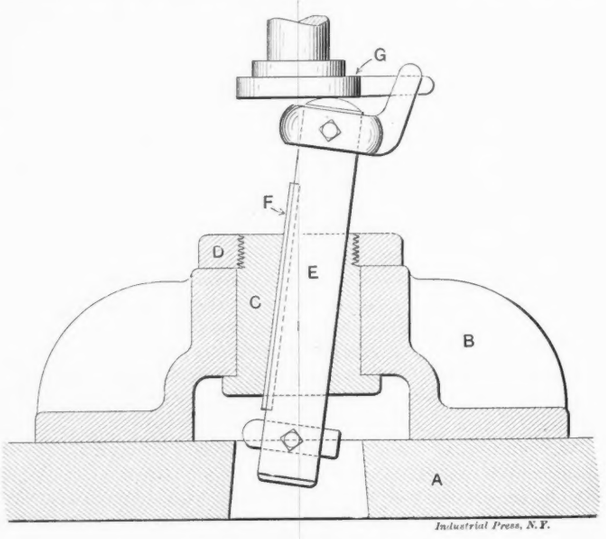
Now, it would scarcely be considered good practice to use the metal from the center of a forging or steel casting for any important purpose, but then conditions were different, and possibly Krupp knew how to insure the integrity of such product. At any rate it indicates something of the wonderful powers of the man chiefly responsible for the development of the greatest European industry. F. EMERSON.

Newark, N. J.

DRILLING TAPERED HOLES ON THE RADIAL DRILL.

Editor MACHINERY:

Some time ago a job of drilling came to my notice which I think will interest some of the readers of MACHINERY. In a large disk, which formed a part of a machine for making mineral briquettes, it was necessary to drill a series of tapering holes that increased in diameter as they receded from the face of the plate. In the figure, *A* represents the plate and the section shows the taper of the holes which were about four inches in diameter at the top. These holes were drilled under a radial drill by the aid of the jig shown in the cut. The cast iron frame *B* was firmly clamped to the face of the disk so that the center line of the jig coincided with the hole to be drilled. The bronze bushing *C* was held by the nut *D* so that it made a smooth running fit in the body of the casting. Through this bushing was drilled a hole making the same angle with the axis of the bushing that the



Jig for Drilling Tapered Holes.

sides of the hole were to make with its axis. The boring bar *E* was free to slide up and down in this hole, but the key *F* caused the bar and bushing to revolve together. On the end of the radial drill spindle was clamped the driving dog, *G*, the arm of which engaged an ordinary lathe dog clamped to the upper end of the boring bar. It will be apparent from the sketch that as the bar was fed downward the hole would be bored to the required taper.

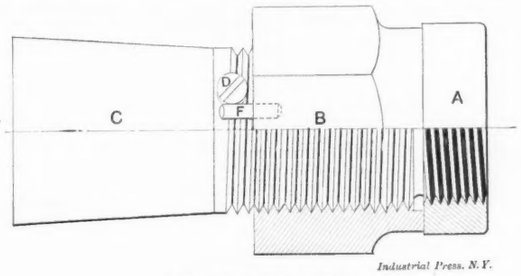
Providence, R. I. J. W. PRELL.

SCREW ARBOR FOR TURNING COLLARS.

Editor MACHINERY:

We have as a regular job a large number of threaded collars to be made on the turret lathe. Considerable trouble was experienced in turning these on a solid arbor, owing to the difficulty of removing them when finished. To overcome this trouble, the arbor shown on next page was designed combining, as it does, the stiffness of the solid arbor and the quick action of a split arbor. By the first operation the hole is

drilled and threaded and one side of the collar is faced, then it is ready to be finished on this arbor. The shank of the arbor fits the turret and the front end is threaded to a good fit in the collar. Directly beyond this thread is a second threaded section, somewhat coarser than the first and left-handed. This second thread is sufficiently large to allow the hexagon nut to be passed over the first thread. This nut is turned on its front end to a diameter slightly below that of the collar, in order to give clearance in turning the top. As will be seen, the collar butts up against the nut with the



Arbor for Turning Collars.

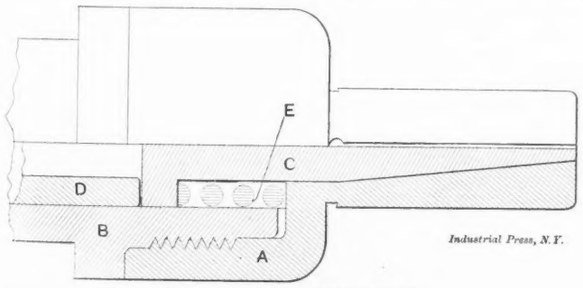
left-hand thread and remains secure no matter how heavy the strain put upon it. When, however, the collar is finished, a slight turn of the nut will release all pressure and the collar may be unscrewed with the fingers. Before another collar is placed on the arbor the nut is returned to its first position by bringing the pin *F*, in the nut, against the screw *D*, in the arbor. This arrangement is necessary in order to use the automatic stops on the turret and insure getting all the collars of the same thickness.

Lawrence, Mass. CHARLES P. THIEL.

AN EXPANSION CHUCK FOR THE SCREW MACHINE.

Editor MACHINERY:

We were making hundreds of shells 2⅛ inches outside diameter and 1 15-16 inside, on the outside of which it was necessary to perform several operations and make them perfectly true with the hole. We were at first perplexed to find a way to hold these shells but finally solved our difficulty by the adoption of the spring chuck, here shown, which was simple and can be used on any screw machine that is provided with a wire feed. The body of the chuck, *A*, is made of machine steel and four longitudinal slots extend the full length of the portion on which the work is held. When the chuck was made these slots were stopped a little way short of the



Expansion Screw Machine Chuck.

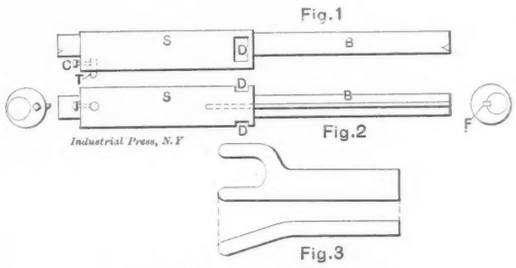
forward end, leaving a small tie which held the piece in shape while it was being hardened. This was afterward cut through with a circular lap. After these fins were cut away the taper portion and the part that fits the spindle were lapped out so as to be perfectly in line with each other. I then made an arbor to fit these holes and ground off the back of the chuck.

The plunger, *C*, is made of tool steel, hardened and ground, the length being governed by the wire feed so that the quill of the machine will act the same upon it as it does on ordinary collets. The taper on our chuck was 11 degrees on a side and it was afterward found that this taper was sufficient to cause the chuck to release itself, so that the spring was not needed. Should the taper be made less, however, the spring would be necessary. *B* is the spindle of the machine and *D* the quill which forces the plunger into the chuck. After the parts were assembled the chuck was put in the machine and by the use of a grinding attachment, held in the turret, the portion upon which the work fits was ground and then lapped to a good close fit in the holes in the work. As these holes were all made to plug gage the chuck worked very nicely. In each of the four slots was fitted a piece of fiber which kept out all chips and dirt. J. M. S.

BORING BARS.

Editor MACHINERY:

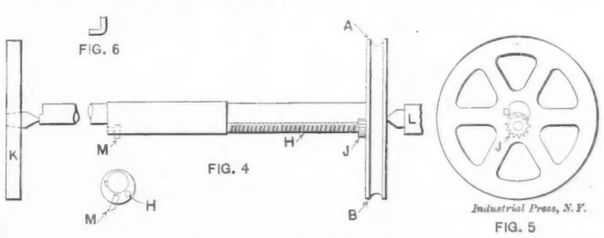
Fig. 1 shows the plan and Fig. 2 the side view of a boring bar that I have used with success for both straight and tapered work. It consists of a bar, *B*, whose centers are offset enough to bring the eccentric sleeve, *S*, central with the lathe centers. The object in making this sleeve eccentric is to make more room for fastening the cutting tool. The bar is splined for about three-fifths of its length and a feather, *F*, fitting



A Convenient Form of Boring Bar.

tight in the sleeve and sliding in the spline, keeps the sleeve from turning on the bar. The cutting tool, *T*, is held in place by means of the set screw, *C*. Fig. 3 shows the form of driver that is used. The jaws are placed in the slots, *DD*, Fig. 2, and the straight end is fastened in the tool post, like an ordinary lathe tool. The carriage feed is used to feed the sleeve along the bar while the tailstock is set over to get tapers the same as in turning work held on the centers.

I also submit a sketch of a rig for re-boring lathe headstock boxes which "Connecticut" asks for in the September number of MACHINERY; this is shown in Figs. 4, 5 and 6. The headstock is left in its normal position on the lathe bed and the plate, *K*, which is supplied with a center, is clamped to the back end of the headstock with its center true with the lathe spindle, thus forming a bearing for one end of the bar, while the other end runs on the tailstock center, *L*. The sheave is securely keyed to the bar and is driven, by means of a rope drive, from any convenient line of shafting. If desired a pulley and belt may be substituted for the sheave and rope. The bar is provided with an eccentric sleeve which carries the cutting tool and is prevented from turning on the bar by a feather the same as shown in Fig. 2. The sleeve is threaded to fit the feed screw for about one and one-half inches on the end that the screw enters, and a clearance hole is drilled the rest of the way through. Fig. 5, which is a section on the line, *A B*, shows how the toothed wheel, *J*, is



Bar for Boring Lathe Boxes.

let into the bar. The toothed wheel is rigid on the feed screw and is turned slightly at every revolution by coming in contact with a bar held in the toolpost for that purpose. The headstock end of the bar is made as shown, for boxes that are tapped out on the back end to receive an adjusting screw, the reduced size entering the tapped hole. By using a cutting tool as shown in Fig. 6, which projects a little beyond the end of the sleeve such a box can be bored and also faced.

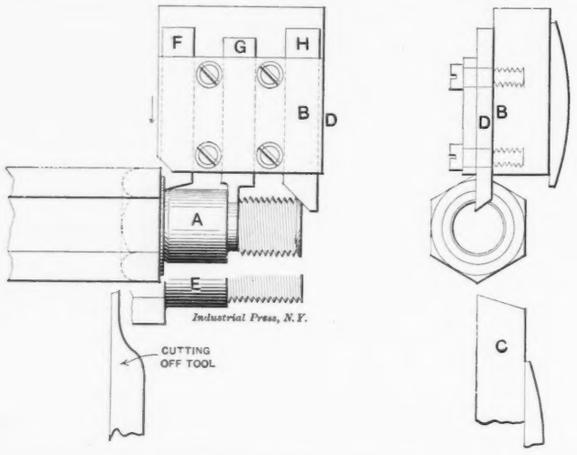
Watervliet, N. Y. M. H. BALL.

SCREW MACHINE TOOLS FOR MAKING BOLTS.

Editor MACHINERY:

I had several thousands of the bolts shown at *A* to make from hexagon stock on the screw machine. Three turning tools were used and it was found very difficult to keep them set so as to always make the corners square and of the correct length. So I adopted the method shown in the sketch.

This method, which is described here, worked very successfully. The bolts were first turned, nearly to finished size, with the regular turning tools, as shown at *E*. On the back toolpost of the cut-off slide was mounted the tool holder, *B*,



Screw Machine Tools for Bolt Making.

in which are set the tools *F*, *G* and *H*. When the bolt had been rough turned, as previously described, these tools were then run up to a stop and the bolt finished as at *A*. As these tools have but little stock to remove they seldom require grinding and therefore save a great deal of time and insure accurate work. After the body of the bolt has been finished as described it is cut from the bar with the cutting-off tool shown at *C*, which while cutting chamfers the corners, at the same time, thus completing the bolt. JAMES P. HAYES.

Meriden, Conn.

A HANDY JIG TO HAVE AROUND THE SHOP.

Editor MACHINERY:

The photograph shows a tool that we made two or three years ago, which does not seem to be generally known or used. It has proved of so much convenience to us that we think a description may be appreciated by others who have similar work to do. As will be seen, it consists of an angle plate which is capable of holding studs of different diameters

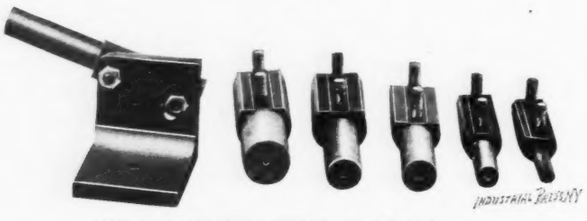


Fig. 1. Jig for Drilling Set Screw and Oil Holes.

horizontally or at an angle. It is used for drilling setscrew and oil holes in pulleys, gears and other similar work. The studs, five of which are shown in the photographs, range in size from ¼-inch to 2 inches in diameter. The smaller sizes, up to ⅝-inch, are driven into the backs of the larger ones, thus saving the expense of making complete studs for these sizes.

As with nearly all new tools, if a second one were to be made it would be different in some respects from the original. The objection to the present tool is that the movement of the studs is somewhat limited, so if another were being built it should be as shown in Fig. 2, in which it will be seen that the studs may be set horizontally, vertically or at any angle between. Fig. 3 is a dimensioned drawing of one of the studs, which will give a general idea of their size, although, of course, the dimensions are varied for the different sizes of studs. They are made from stock somewhat larger than the diameter of the stud required and are turned with as much eccentricity as possible in order to obtain a sufficiently large flat surface for clamping to the angle plate. For work that requires to be held rigidly the studs could be made to expand on the same principle that is employed for expanding arbors or reamers. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

REGARDING LARGE OIL TANKS.

Editor MACHINERY:

In your publication Vol. 9, No. 1 for September last, under "Notes and Comments" (Engineering Edition) we see it stated that what is said to be the largest steel tank in the world has been completed at Boston for the Atlantic Refining Co., and measures 36 feet high, with a diameter of 90 feet. We, in this country, are specialists in the oil tank line, and think that you will find the following particulars of current contracts which we are executing, of sufficient interest to your readers to merit notice in an early issue of your journal.

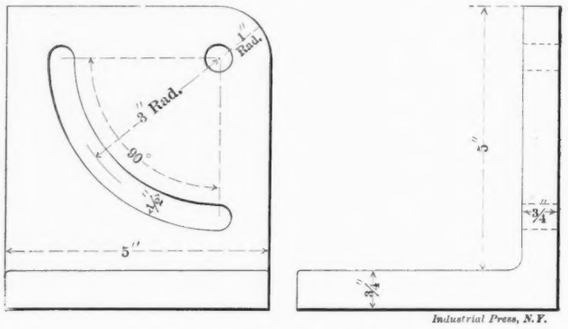


Fig. 2. Base of the Drilling Jig.

Catalogue page 79 enclosed, shows a view of tanks, 58 feet 6 inches diameter, by 30 feet high, built and erected for the Burma Oil Co., Ltd., also tanks, 64 feet diameter, by 34 feet 10 inches high, built and erected for the Standard Oil Co., of New York. These were installed at Budge Budge, the great oil depot for this side of India, and are typical of similar contracts carried out by us in other parts of the country.

Our most important contract at present in progress of execution is for the Standard Oil Co., of New York, and consists of two steel tanks each 90 feet diameter, by 38 feet 6 inches high to top of roof. The capacity of each tank is considerably over 1,250,000 gallons. The bottom, which is double-riveted, weighs 46 tons and is composed of 67 plates ⅜-inch thick, maximum sizes rolled being used. In this part of the work there are 15,200 rivets. The maximum size of plates has also been used for side of tanks, there being 13

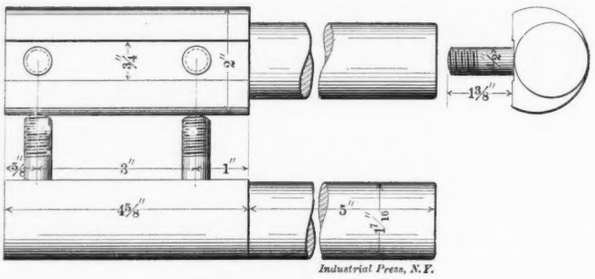


Fig. 3. One of the Drilling Studs.

plates in circumference; the bottom strake is 9-16-inch thick, each plate weighing 3,360 pounds. There are 240 ⅛-inch plates and 12,500 rivets in each roof, the net weight of rivets in a tank being 15,680 pounds.

For the above and for other oil companies we have, in the aggregate, close on 100 smaller tanks actually in hand at present, for erection all over India. Each tank is built up

from the imported raw material. Our works, we may say, have an area of 35 acres—exclusive of our drydocks and saw mills.

Howrah, India. BURN & Co.

[The item referred to, is in error as regards capacity and as being the largest, even in this country. The maximum capacity of a tank 90 feet in diameter and 36 feet high, is about 34,260 barrels of 50 U. S. gallons, capacity. Mr. H. C. Folger, Jr., of the Standard Oil Co., informs us that a number of oil tanks have been constructed in the United States to hold 50,000 barrels and some even larger. The very large tanks are in the Texas oil fields.—EDITOR.]

METHOD OF MACHINING SLIDE VALVES.

Editor MACHINERY:

The economy of milling over most planing operations is pretty generally understood, and we are very much in favor of the duplex face or butt mill type of machine. The machining of an ordinary slide valve is one of the operations for which we have lately used the miller. The work was for many

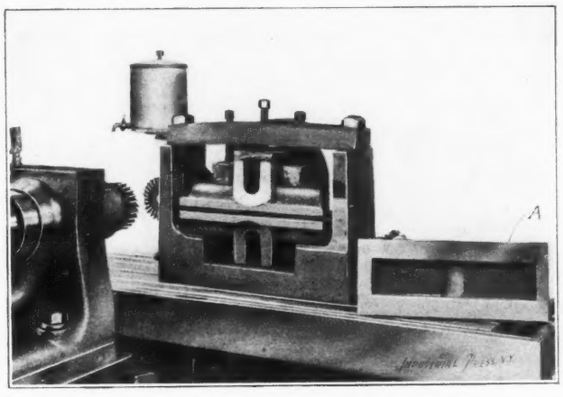


Fig. 1. Machining Slide Valves, First Operation.

years done by planing, and as large numbers were made, suitable fixtures were used so that several could be machined at once. They were also done at piece work, so we may infer that the planing was accomplished in a reasonable time, one and one-half hours being the average.

The first operation, illustrated in Fig. 1, is to mill the edges of the valves at *A*, it being essential that the edges shall be parallel with the exhaust port. To accomplish this the valves are placed, one on the top and one on the bottom, of the steel plate on which are bosses the same length and

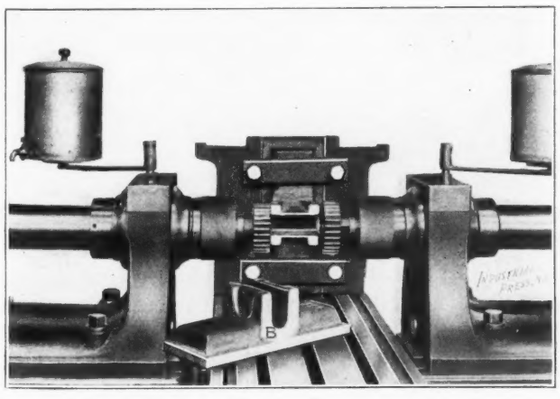


Fig. 2. Machining Slide Valves, Second Operation.

width as the exhaust ports into which they fit. This plate, bearing the two valves, is then fitted into grooves in the milling fixture so that the valves are held with the exhaust port parallel with the travel of the machine. In this way the first operation is performed on both sides of two valves simultaneously.

The second operation is to mill the valve stem lug *B*, Fig. 2. The fixture in which this operation is performed is simply an angle plate with a groove planed in its face the same width as the valve. In this plate the valve is held by a pair of latch clamps which have a spring under them, holding them up in position so that but a single turn of the clamping nut is required to clamp or release the work.

The next operation, which is to mill the face, is performed in the fixture shown in Fig. 3. This fixture is an I-shaped chuck having a row of setscrews on top, along its two edges, by which the work is securely held. This is the most particular part of the job and the cutters need to be in best

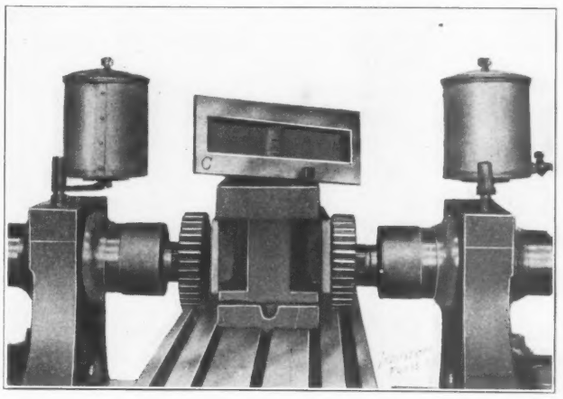


Fig. 3. Machining Slide Valves, Third Operation.

condition and the feed must not be forced too much, but in this operation eight minutes only is consumed in finishing the face of the two valves.

The fourth operation, which completes the work, is to mill each end at a given distance from the center. This is performed with an end mill, on an ordinary plain miller, the valve being held in the fixture shown in Fig. 4. One valve is shown in position, the valve stem lug *B* being held against the stop pin *D*, while the edge *A* is held squarely against the planed shoulder *E*. The second valve is held in the other half of the fixture in the same manner, so that while one piece is being milled another piece is being jigged and the ma-

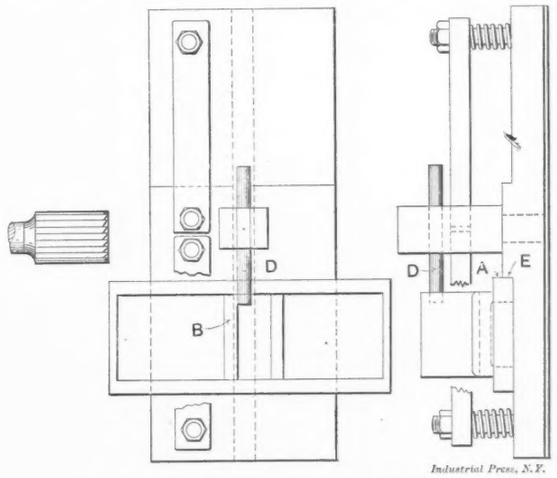


Fig. 4. Machining Slide Valves, Fourth Operation.

chine need not be stopped until the entire lot is completed.

The operators on the machines were apprentices in their first year, at $1.00 per day, and they completed the lot of valves in twenty-nine minutes each. Of course the writer regulated the speeds and feeds of the machine, as well as the speed of the boy. A. A. AVERY.

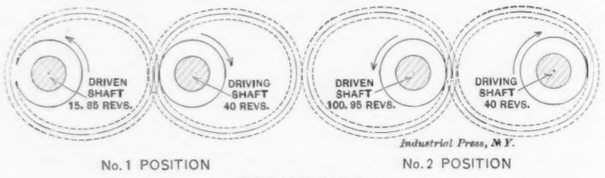
Warren, Pa.

ELLIPTICAL GEARING.

Editor MACHINERY:

The builders of presses and other machines for the press working of metals do not seem to place much value on what is called the element of time in the construction of their machines. Forming tools, punches and other tools that are used

in changing the form of metals, have in most cases the chopping movement, going down to the work as fast as they go up, advancing at the same speed as they recede. A slow movement of the punch or forming tool is valuable in several ways. It prevents sudden strains from injuring the press, favors the punches and dies, allows them to be run longer without having to be ground or replaced, and in a great many cases permits the use of a less expensive metal for the tools. During an experience of many years in using and building presses, the writer has become strongly attached to the use of the elliptical gear. These, while giving the powerful alternating leverage, the slow advance and the quick return, are capable, when properly designed, of furnishing as much or as little of the element of time as may be desired.



Elliptical Gears.

The sketches show a pair of elliptical gears in the two effective positions and illustrate the slowness with which the tool is forced through the work and rapidity with which it returns to position for the next stroke. These gears have a leverage of about 2½ to 1. The large end describes a circle, the diameter of which is equal to that of a 53 tooth gear, while the small end moves in a circle whose diameter is that of a 21 tooth pinion. No. 1 position shows the relation of the gears when the punch or tool is being driven down at a rate of 15.85 revolutions per minute. No. 2 position, when the tool is being withdrawn from the work at the rate of 100.95 revolutions per minute. E. M. LEHMAN.

Chicago, Ill.

A HOME-MADE T-SQUARE ATTACHMENT.

Editor MACHINERY:

In every draftsman's daily work he has continually to use his triangle at angles other than those found on the regular 30-60 and 45 degree triangles. For this purpose I have made the attachment shown in Fig. 1, which has proved very useful in a great number of cases. The base *A* is made of a piece of wood about one-quarter of an inch thick and ten inches long. In the center of this base is firmly fastened a thin strip of steel carrying at its top the thumb tack *B*, which serves as a pivot for the triangle *C*. About this pivot the triangle is swung into any desired position, after which it is held in place by means of the retaining strip *D*. This strip is pivoted to the triangle at *E* and is held down to the base of the attachment by a thumb tack passed through one of the holes *F*, *F*, *F*. In this way the triangle may be held firmly in any position desired, and it may be easily set at any required angle by the use of a protractor. A few of the useful applications of this attachment are shown in Fig. 2 and many others will suggest themselves to the draftsman as he becomes familiar with the use of the instrument.

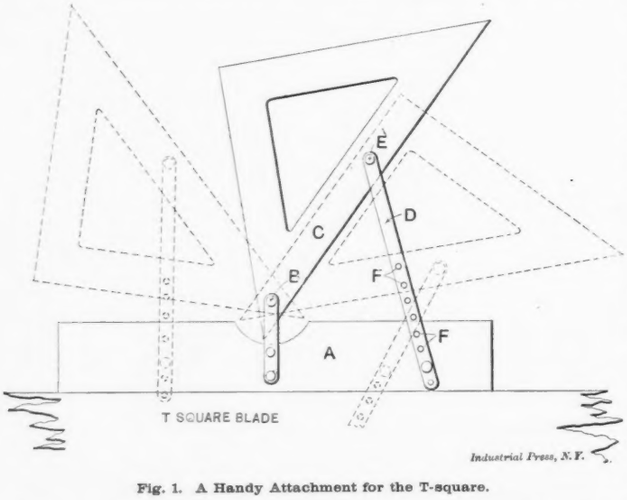


Fig. 1. A Handy Attachment for the T-square.

In constructing this arrangement any 45 or 30-60 triangle can be used and for the strips I employed pieces of an old hack saw, but strips of brass or other metal will, of course, answer the purpose equally well. A. McA.

RIGHT AND WRONG WAYS.

Editor MACHINERY:

While working in different shops in this country, in England and France, various examples of the right and the wrong way to do a job have come to my notice and I think that some of these cases may be of interest and possibly benefit to the readers of MACHINERY.

An order came into the shop one day for a lot of screws, about three feet long by two and a half inches in diameter, having six threads (or a sextuple thread). The turners were on piece work and started cutting them in the usual way, by dividing the change wheel into six equal parts and cutting thread by thread. One, however, more enterprising than the rest, made a gage which was as long as the lead, and had six equally divided spaces in it, which were equal to the spaces between the threads. Next he got six tools forged and ground to the right dimensions and fixed these on the rest so that each one would just go into a space in the gage and were all in line; then putting in the change wheels, he started the lathe and cut *the six threads all at once.*

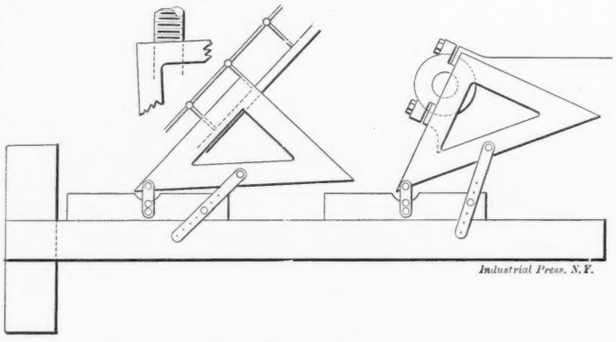


Fig. 2. Some of the Uses for the T-square Attachment.

I remember a lot of bolts being made about 12 inches long by two inches diameter, threaded at one end, with a hexagon head at the other. These were faced up and the centers thereby turned off. It was then found best to turn them down a little in the middle as they fitted too tightly in the holes. It looked as though all those bolts would have to be centered again before the turning could be done, so they were taken to the lathe man and he was told to go ahead—and go ahead he did. He found a short box spanner which would fit the bolt head and this he put in the chuck jaws, setting it to run true. Next he got a steady rest with two semicircular wooden blocks which just fitted the threaded part; these were lined with tin to prevent the threads from cutting the wood out. Having everything ready he picked up a bolt, put the head in the box spanner, and the screwed end in the steady rest, started the lathe and put the cut on at once. The tool traveling toward the headstock pressed the bolt into the box spanner, and so prevented it from working out. One cut across was enough to take off the required quantity of metal and he finished those bolts in such short time that the foreman would hardly believe his eyes when he saw them turned and yet uncentered.

He was a bit different from the man who, when given some left-hand screws to cut, set to work and rigged up the lathe to run backwards, turned the tool upside down, and proceeded to cut what he thought would be a left-handed screw. He must have been considerably astonished at the result.

A few years ago a hydraulic press had to be moved—it was a large one of about 800 tons pressure. The ram was in the bottom casting, and the top was held up by four large columns. The man who had charge of the job went to a lot of trouble to get it apart; he got derricks, ropes, blocks, etc.,

had a regular gang of laborers and, in time, with a lot of shouting and bossing he got it to pieces. It was then erected in the new place. Lately it was taken down to make room for a more powerful machine and a young mechanic was put in charge. He didn't cut off the water pressure first of all, then get derricks, etc. No! he took the four nuts off the top of the press, put a lot of packing on the press table, opened the valve and as the ram went up it lifted the top casting clear of the columns. This top was then barred through 90 degrees and the ram lowered, which let it down between the columns. The ram next brought it down to the level of the floor and it was rolled away to the crane. Next a crosspiece was fixed to the ram table and to the two opposite columns, the lower nuts were taken off, the ram sent up, and it pulled out the two columns which were allowed to fall to the ground, being guided by ropes. In the same way the other two were removed. The ram was next lifted up as far as safe and secured from toppling over by four ropes, after which it was pumped completely out of the hole, the ropes slowly slackened allowing it to fall to the ground. The water pipes were now disconnected and the bottom casting lifted by hydraulic jacks. All this took the mighty force of the mechanic and his laborer; no derricks, blocks or special tackle were used; only a few ropes, and it was done in about one-sixth of the time it took the other man, who had worked hard but did not think.

That reminds me of a man I knew who had to repair a double cylinder engine, and after taking it to pieces and doing the necessary repairs carefully put it together, gathered up his tools, just started the engine to make sure it was all right, and I think he was the most surprised man in that State when he saw the engine run—well, but the wrong way. After using up a lot of brain energy it dawned on him that the crankshaft and cranks were turned end for end. He was in a nasty temper for the rest of the day.

In placing a steam valve, remember there is a right and a wrong way to connect it up. I have known many cases where they have been placed upside down. The valve should always be placed so as to close against the in-flowing steam, that will cut off the steam from the side of the valve where the handwheel and stuffing box is located, so when the packing gets worn it is only necessary to close the valve and repack. If the valve is put in the other way it is impossible to pack it without shutting off the steam at another valve, which is generally inconvenient.

There was once a steam pump, pumping water to a high tank with the inlet pipe at the bottom of the tank. The pump did not work well, and the boss, after long consideration, decided that there was too much *weight* of water to pump against. So he had the inlet pipe removed from the bottom, another length joined on, and turned over the top of the tank. Thus the water would be pumped over the top and run into it. He could never understand why the pump instead of being better was worse, if anything, after *easing*(?) the load so much. It was a pity he never studied elementary hydraulics.

I have noticed lately there has been a lot of discussion about making things theoretically and not practically correct. I have seen many cases of this; one was where a draftsman, after using his slide rule and table of "Strengths of Materials," designed a cast iron hydraulic cylinder for low water pressure to be cast with the wall three-sixteenths of an inch thick by twenty inches in diameter. It was quite strong enough theoretically and did not (or would not, for it was cast five-eighths) use much metal. But for all that, he fell a good deal in the chief's estimation.

He was nearly as bad as the draftsman who was preparing drawings for some machinery. A brick wall which was to be two and a half bricks thick, came between some of the parts. A brick is nine inches long and nine inches multiplied by two and a half equals twenty-two and a half inches. This he put down as the thickness of the wall. *He forgot the mortar*, and when the wall was built it was twenty-four inches thick, which made such a difference to the machinery that a lot of alterations were necessary.

Mistakes like these are, in my opinion, due to the draftsman not having enough practical experience. The great majority only just rush through the shops doing patternmaking, machining, and fitting (no molding as a rule) in about a year, then they think they have had a good, varied, practical experience.

GEO. P. PEARCE.

Williamsport, Pa.

A FRICTION CLUTCH PULLEY AND THE JIG FOR TURNING THE FRICTION SHOES.

Editor MACHINERY:

The photograph, Fig. 1, shows a special chuck that is used for turning clutch shoes and Fig. 2 shows the friction pulley in which these shoes are used. When the clutch was designed these shoes were fortunately made to take up a little less than 90 degrees, making it possible to place four in a circle. I say "fortunately" because it was not done with that purpose in view, as we expected to build a revolving fixture for the milling machine and mill them as we are doing with the shoes for a smaller size of these clutches. But as there was already more milling than our capacity conveniently allowed we were compelled to resort to the lathe and, although it is not possible to tell whether or not the miller would have done the work quicker, it is sure that we are well satisfied with the amount of work turned out with this chuck. It is fitted to the faceplate with eight dowels, and four capscrews tapped into it from the back hold it fast.

Here let me say a word about dowelling special chucks to a faceplate. Some do not like the practice because it impairs the "looks" of the faceplate. This is true, in one sense, but it is also true that "handsome is that handsome does" and the

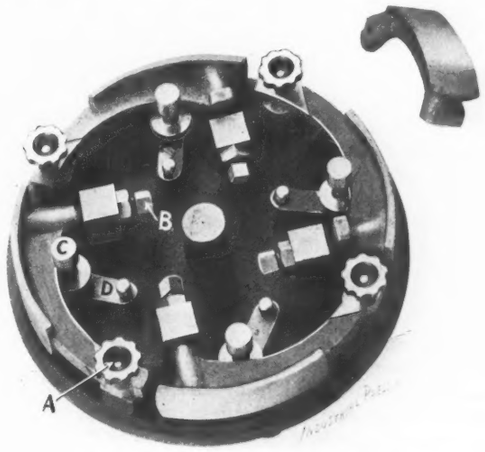


Fig. 1. Jig for Turning Clutch Pulley Shoe.

time saved by dowelling as many as possible of the special chucks to the faceplate would pay for another if one were bound to have one not perforated with dowel holes. When a number of chucks have been dowelled to a faceplate it is often difficult to find the right holes, even if they have been numbered. This is usually caused by numbering too many of the holes and using the same number more than once. It is neither necessary nor desirable to number more than two of the dowels and corresponding holes for each fixture, as when these are found the rest of them will, of course, drop in. When the first fixture is dowelled to a faceplate two of its dowels should be marked 0 and 1, two of the next one 2 and 3, etc.; there will then be no trouble in finding the right holes and the faceplate will look at its best when a large number of holes indicate that it has been made "good and useful." The foregoing relates only to that class of chuck that cannot very well be made to screw onto the spindle nose in place of the faceplate.

To return to the chuck in question, it is principally different from many others in that neither wrenches nor measuring tools are needed in its use. As the four quarters of the chuck are identical, but one needs be considered in describing it. The fulcrum end of the shoe, having been previously milled with straddle mills and drilled, is placed on the stud in the chuck and the nut, *A*, tightened by hand while the other end of the shoe is left some distance away from screw *B;* then, pressing the shoe down onto this screw the nut *A* is "helped along" tightening it firmly. Screw *B* was adjusted when the chuck

was made and is not again disturbed. Collarscrew *C* is now unscrewed till its collar touches the back side of the rib on the shoe and levernut *D* is tightened to lock it. This supports the shoe against the side pressure of the tool, which is fed toward the faceplate. The clutchshoe is now firmly held and the tool being adjusted to a setpiece on the chuck, a roughing and then a finishing cut are taken. The force of the cut presses the piece firmly down on screw *B* and there is no tendency to tear away. Although these shoes are to be faced with leather it is essential that the outer surface conform as nearly as possible to the clutch rim on the pulley. Should it fail to fit the rim the leather would engage it at one end

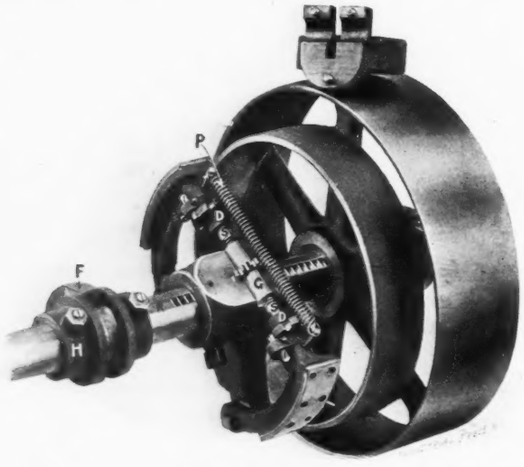


Fig. 2. Clutch Pulley.

only and the pulley would be crowded to one side on its sleeve and, less surface being in contact, the clutch would not drive so well.

The construction and action of the clutch in which these shoes are used is so different from any other that a brief description of it may be of interest. In the photograph, Fig. 2, the pulley has been slipped back on the shaft and the cap removed from over the gear to expose the working parts to view. A rectangular groove is milled in the shaft and therein slides a toothed rack *R* meshing with gear *G*. The rack is attached to a grooved sliding hub *H*, which is moved laterally in the usual manner by fork *F* on the shifter rod. Gear *G* has a long hub, one end of which is threaded right and the other left hand. The screws *SS* are held from turning by the lockpins *II*, each engaged in a notch of the disks *DD*, which are fast on the screws. When the gear rotates the screws the shoes will be either forced outward or allowed to be drawn inward by the spring *P*, according to the direction of rotation. When the leather wears away so sliding hub *H* will reach the hub of the clutch before the shoes are expanded sufficiently, the cotterpins passing through lockpins *II* are withdrawn, and the expanding screws *SS* may be turned to another notch and again locked. This adjustment is readily made without the aid of any tools. It, however, needs be made but very seldom as the latter is very durable when in contact with metal and the old story of a rawhide lace-leather hanging over a line-shaft and wearing it in two is not entirely without foundation.

When these clutches were first designed there were some doubts concerning the enduring powers of leather, so, as I preferred leather to wood or fiber, a preliminary test seemed advisable. A countershaft for a lathe being equipped with a pair of clutchpulleys its shifter rod was connected through a bellcrank to an improvised crankpin on the faceplate of another lathe and when it had been reversed considerably over one hundred thousand times under a heavy load the leather was found to be reduced one-hundredth inch in thickness. This was some eighteen months ago; the countershaft has been in daily use since and there appears to be several years of service left in the leathers. The principal beauty of this clutch is the very small effort required to operate it, as the clutchshoes are actually *screwed* into contact with the clutch rim so that with the tip of the little finger at the shifter lever the clutch may be engaged tight enough to slip the belts.

Although designed primarily for use on friction countershafts for machine tools its good points have introduced it in other establishments and even in woodworking shops it is preferred to the common tight and loose pulleys. Some of them used at woodworking shops are running at 800 to 1,100 turns per minute, a speed reached successfully by very few friction clutches.

CORNEIL RIDDERHOF.

PATTERN FOR AN OBLIQUE CHUTE.

Editor MACHINERY:

Pattern makers occasionally meet with problems that are exceedingly perplexing, especially to those who have neglected the study of geometry; moreover such problems are often by no means easy to solve even by those fairly informed in that science. Fig. 1 shows the pattern which is the subject of one of those problems. A cast iron chute rectangular in section is required to pass in an oblique direction through a brick wall 17½ inches thick. It passes through at an angle of 35 degrees with the perpendicular and 45 degrees with the face of the wall. As the illustration shows, the chute emerges from the wall with its sides parallel with the vertical joints of the brick work, but its top and bottom are oblique to the horizontal joints of the wall. This obliquity results from the combination of angles and the rectangular section of the chute. There are several ways of determining the length of the pattern and the angle of its ends in such a case, and two of these ways will be described.

In order to obtain the proper dimensions and angles of the pattern it is advisable to lay down full size the necessary views, as illustrated in Fig. 2. First draw the plan *A*, making *a* equal to the thickness of the wall and *b* equal to the base of the required triangle horizontally. In this case the horizontal angle being 45 degrees makes both sides of the triangle 17½ inches. Draw the line *d* parallel with the hypotenuse *c* and make the perpendicular distance between the two lines equal to the external width of the chute, 14 inches, and extend *d* to *e*. Draw the side elevation *B* equal to the thickness of the wall, making the line *f* 35 degrees with the perpendicular. Project a line from *g* toward *h* and extend it indefinitely. Project the point *i* toward *k* and extend it indefinitely. Project the point *l* and intersect *i k* at *k;* connect *k m*, this line will give the angle of the chute through the

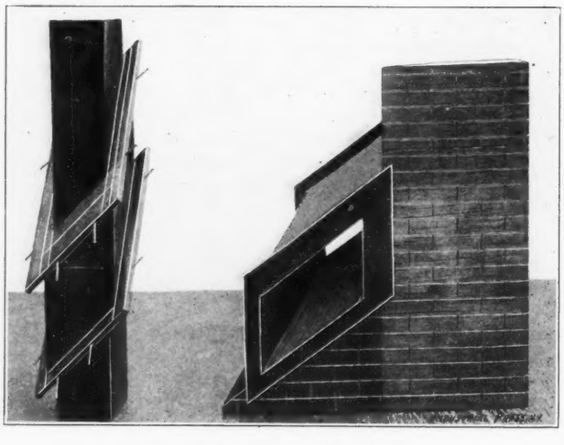


Fig. 1. Pattern for an Oblique Chute.

wall when viewed in front elevation. Project the point *e*, and intersect the line *g h* at *h*. Project the point *n* toward *o* and extend it indefinitely. From the point *h* draw the line *h p* parallel with *m k* intersecting *n o* at *o*, connect *k o* and the length of the line so formed will equal the length of the angular side on the top and bottom of the chute at its ends. So far while we have arrived at the width of the chute, also the angle of the ends on the top and bottom, there is no line that gives the actual length of the chute, because to obtain that it is necessary to have a view from a point perpendicular to the side; the side being obliquely viewed in

that which has been drawn. The actual length of the chute through the wall is the diagonal line, or hypotenuse of the angle whose sides are the line f and the length of the thickness of the wall q. Draw q perpendicular to the end of f making the length equal to the thickness of the wall, connect the extremities of f and q and the hypotenuse r will equal the actual length through the wall, and between the flanges of the chute; this line also furnishes the basis for obtaining

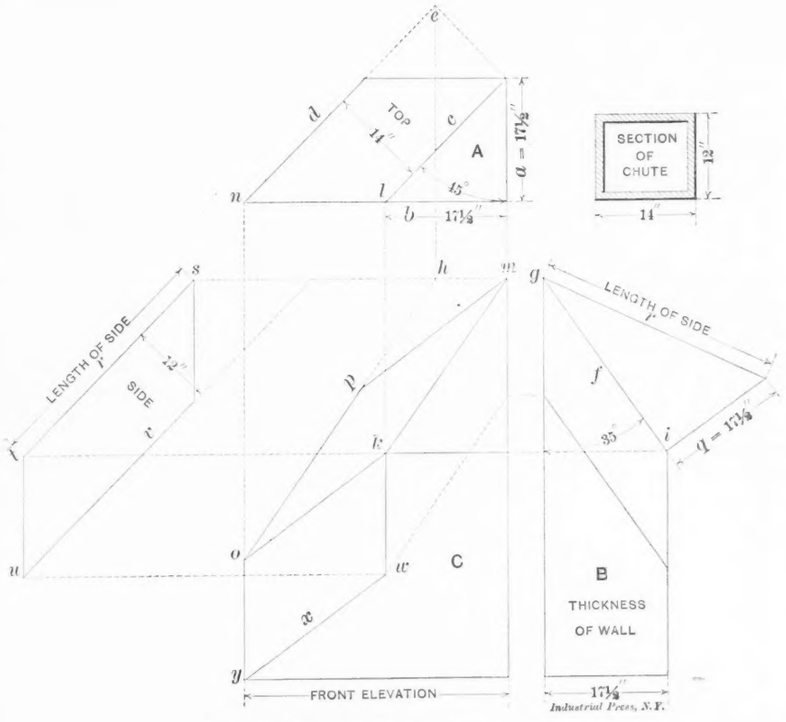


Fig. 2. Development of Pattern for Oblique Chute.

the angle of the ends of the chute on its sides. With the length of the line r intersect $g\,h$ at s and $i\,k$ at t, and draw $t\,u$ parallel with $n\,o$. Draw v parallel with r making the perpendicular distance between the two lines equal to the external thickness or depth of the chute. Let v intersect $t\,u$ at u, the length $t\,u$ will then equal the depth of the end of the chute where it emerges from the wall, and the angle so formed will be the angle of the ends on the side of the

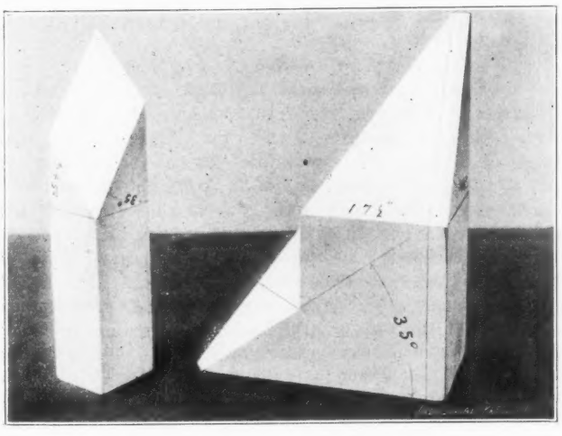


Fig. 3. Wooden Model for Oblique Chute Pattern.

chute. Project and make $k\,w$ equal to $t\,u$; from w draw x parallel with $o\,k$ intersecting $n\,o$ at y, and the rhomboid so formed by $k\,o$ and $w\,y$ will be the figure of the end of the chute, minus the flange, when viewed perpendicular to the end, as it emerges from the wall. Having determined the most important part of the problem, and proper length and angles for the pattern, its construction is not difficult. The pattern complete except the core box, which is a plain rectangular one, is shown at the left in Fig. 1.

To begin the pattern a box or core print whose cross section equals that of the interior of the chute, is built up of one inch material; the length of the print is sufficient to allow bearings for the core beyond the flanges at each end. Upon the print the length and angles of the pattern are lined off and the thickness for the metal planted on in conformity with the lines. Where the thickness forms undercuts, as at one end of the sides, the undercut pieces are made to be drawn separately from the body of the pattern; they are secured in place by draw pins. After the thickness is completed the flanges at the end are fitted to the pattern and secured by draw pins; they remain in the sand and are drawn after the body of the pattern has been lifted from the sand.

Another way which the writer has often used with great advantage and unvarying success in working out difficult problems of this character, is to make a wood model to a convenient scale and develop the object from it. He would especially recommend this method where a number of different angles are involved, because it enables one to comprehend the problem more readily by having the chief features of the object under view, thereby impressing them more deeply on the mind and making mistakes less liable.

Fig. 3 shows a model of all that is necessary to solve the present problem, and in making the pattern it would save tenfold time spent in making the model. It is not necessary that such models should be very elaborate, but accuracy is absolutely essential. It so happens in this case that the angles of the ends of the chute agree with those with which it passes through the wall, 35 degrees and 45 degrees, or so near to them that they answer practical purposes; but this result does not follow as a rule for any combination of angles.

A problem of the foregoing character was once submitted to the writer after its solution had baffled the efforts of several excellent draftsmen for a number of days, and he solved it with the aid of a model, which required less than two hours to make.

Washington, D. C. I. McKim Chase.

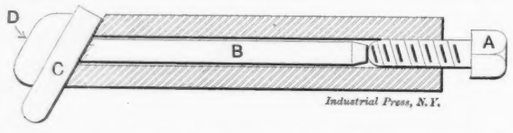
* * *

British engineers quite properly take pride in the durability of their machinery. They intimate that the American habit of scrapping machinery long before it is worn out, is a trick to deceive, and that such machinery is scrapped because it actually had to be, to prevent deterioration of the product. This is, of course, untrue, but it is true in many cases that American design is not as durable as it should be. This fault, however, is being generally corrected without going to the British extreme. A great ado has recently been made in England over the record of a Stephenson locomotive that was put in commission in 1822, and, at last reports, was still running. Such durability is of an extremely expensive kind, as we have time and time again demonstrated in the operation of American railroads—railroads that have the cheapest freight rates in the world. The old engine had been rebuilt so that little if any of the original remains. As to durability, which appeals to the practical American engineer, any mentioned by Mr. J. Davidson in a paper read before the Liverpool Engineering Society, is a good type. He referred to a Willans engine that had run five years in which time its crankshaft had made 535,000,000 revolutions. The crosshead pin was found to be worn in one part only .002 inch, and the connecting rod brasses had worn only .02 in the five years of service. Such a condition indicates good design, first-class fitting and excellent care on the part of the operating engineer.

CONTRIBUTED NOTES AND SHOP KINKS.

BORING TOOL HOLDER.

E. M. Burgess, Springfield, Ohio, sends a sketch of a holder for inserted cutters to be used in boring in such close quarters that a setscrew placed on the end or side of the holder would be in the way. This holder has a hole running from the back end into the tool channel, the hole being tapped



at its outer end for the setscrew *A*. A piece of tool steel *B* with its end beveled and toothed extends from the setscrew up to the tool which it clamps firmly. The end *D* being solid can be made considerably thinner than if it was drilled and tapped for a setscrew.

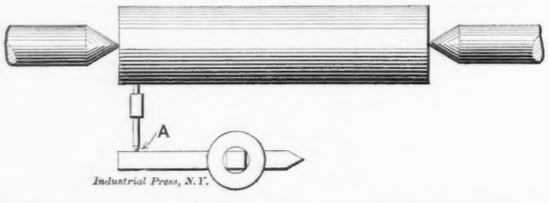
CENTER REST KINK.

Referring to the "kink" in the October MACHINERY, relative to setting work in the center rest, A. C. Muff, Los Angeles, Cal., writes: My method of doing this is to bore out the center rest to the nearest even dimension, using a boring bar held on the lathe centers. Then, when a shaft or other piece of work is placed in the rest a pair of inside calipers is set to the difference between the diameter of the shaft and the bore of the steady rest, and by measuring from the bore the work is very readily brought to a central position.

At our shop we have eight lathes, ranging in size from 8 to 48 inches, and on none of these was the center rest bored out when it was received from the factory. Within a short time I have bored out center rests made by several different lathe builders, and each time I was surprised to see how universally negligent builders are in the construction of this part of the lathe. Not only were these rests left in the rough, but some of them were about a quarter of an inch eccentric. Also the guides for the jaws were not milled accurately and the jaws, when set for small sizes, presented different faces to the work than when set at their largest capacity.

LINING UP THE TAILSTOCK.

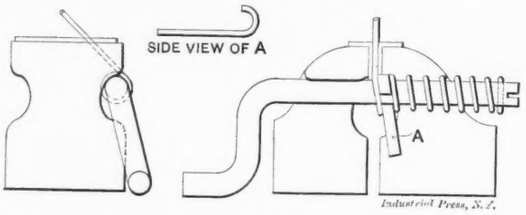
E. M. B. sends a "kink" for lining up a tailstock after it has been set over for taper turning. Select a perfectly straight and true arbor and put it in the centers of the lathe. Then put a punch mark in the side of a lathe tool, near the back end as at *A*. This tool is put in the tool post so that it is approximately parallel with the arbor and so that the punch mark is about on a level with the centers. Placing



one end of an inside micrometer caliper in the punch mark, measure the distance from the tool to the arbor when the carriage is close to the headstock. Run the carriage down to the other end of the arbor and adjust the tailstock to the micrometer. By repeating this operation two or three times the centers can be lined up in a very few minutes.

WINDING SMALL SPRINGS.

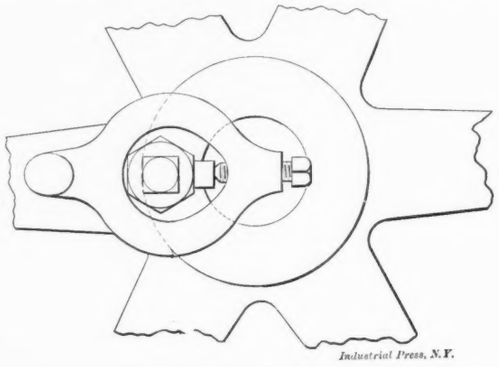
A. C. Muff, Los Angeles, Cal., describes an ingenious and simple way for winding small springs in a vise. In the first place a rod of the diameter of the inside of the spring is bent to form a crank and a small hole drilled in one end to hold the wire while being wound. This rod is placed at one side of the vise, as shown in the sketch, and one end of the wire passed through the hole in the end while the other is led up through the copper jaws of the vise, which are set so as to make an easy fit for it. To get the proper pitches a piece of metal, *A*, the width of which equals the required distance between two coils of the spring, is bent to a half circle at one end while the other is left long, forming a tail. This is hooked over the mandrel at the point of bending and feeds



it along at the desired pitch while the tail strikes against the vise and is thus prevented from turning. When no drill is at hand for drilling the hole in the end, a slot may be filed to answer the same purpose. In this manner the writer has been able to wind all kinds and pitches of springs when doing repair work miles away from a lathe or any tools other than a vise and file.

PULLING A TIGHT KEY.

James F. Willey, Jeffersonville, Ind., in sending in a "kink" says: An aged blacksmith once told me that the best "kinks" could be learned from workmen of very ordinary ability. Whether this be so or not, the one which is here illustrated I saw used by a man whose reputation for quick wit greatly exceeded his skill as a mechanic. He wished to remove a tight key for a pulley on the end of a shaft and the way he



did it is shown in the sketch. With a lathe dog a hexagon nut was clamped tightly against the projecting end of the key and a setscrew was then turned through the nut. The end of this screw bore against the hub of the pulley and as it was turned it raised the nut and consequently drew the key with it.

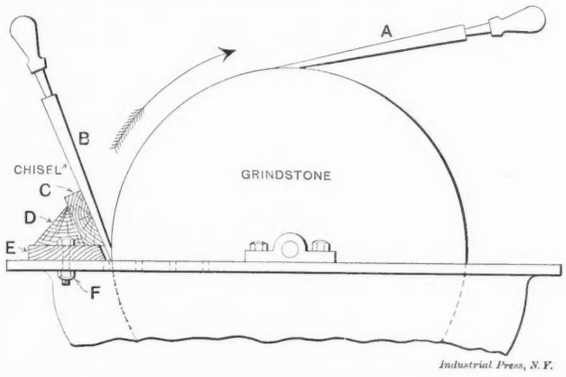
A REAMER KINK.

Charles F. Brandon, Hartford, Conn., sends the following reamer kinks regarding which he says: They would probably be out of place for a first-class tool job but for ordinary work they are frequently very handy. It is often required to ream a hole slightly larger than the size of the reamer at hand. To do this we employ a piece of drill rod about 1-64 inch larger in diameter than the depth of the reamer flutes and long enough to extend through the hole and project a few inches on either side. This rod is thoroughly lubricated and inserted with the reamer in the hole. The reamer is operated in the ordinary manner and the rod crowds it to one side sufficiently to cause it to cut the hole slightly large. Should the enlargement not be sufficient a larger rod may be used or two rods may be put in flutes near together.

A reamer that has become slightly dulled may be sharpened without grinding by the use of a piece of Stubs' drill rod ⅛ to ¼-inch in diameter, depending on the size of the reamer. One end of this rod is hardened as hard as possible and this is inserted in the flutes with the side pressed firmly against the cutting edge of the blade. This is slid up and down a few times against each blade and has the effect of raising a slight burr on the blade which causes it to take hold well and to cut a smooth hole.

JIG FOR GRINDING A CHISEL.

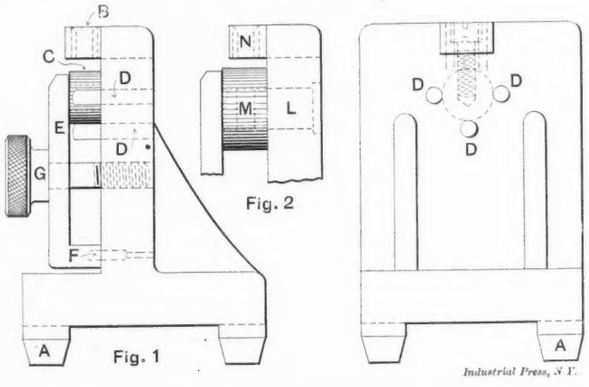
Woodworker writes: Patternmakers and woodworkers who grind chisels, plane irons, etc., in the old way by holding them on the stone as shown at *A* will find the little jig, for holding them as at *B*, to be a great convenience. The two pieces, *C* and *D*, are screwed or nailed together and braced by the bracket *E*. Then the piece *C* is beveled to give the proper angle to the edge of the tool. The fixture is fastened



to each side of the grindstone trough by the bolts *F* and a series of bolt holes is drilled through each flange of the trough so that the jig may be moved in as the wheel is worn down. With this attachment the writer has ground trimming knives as accurately as could have been done on a special emery grinder.

JIG FOR DRILLING COLLARS.

C. H. Rowe, Lynn, Mass., sends the sketch of a jig which he has used with much satisfaction for drilling setscrew holes in collars. The collar *C* is held in position by means of the three locating pins *D*, *D*, *D*, and the swinging clamp *E*. In order to place a collar in position for drilling, the strap is swung to one side about the hand screw *G*. When the collar has been put in place the clamp is swung back and in doing so its motion is limited by the pin *F*, which brings it to a stop directly over the collar. At the top of the jig is



a bushing *B* through which the drill is guided. When the outside diameter of the collars is likely to vary, the pins *D*, *D*, *D*, may be replaced by a central pin, *L*, Fig. 2, and the collar held on this while it is being drilled.

* * *

The great Forth cantilever bridge in Scotland with its two spans of 1,710 feet each, has the longest single spans in the world. It is one of the world's long bridges, being 9,000 feet long. The Tay bridge is the longest great bridge, having a total length of 10,780 and following that is the Ohio River bridge at Cairo, Ill., with a total length of 10,560 feet. The new Manhattan bridge now building across the East River will come next with a length of 9,230 feet. The distinction of having the longest span will soon be taken from the Forth bridge, however. A bridge is to be constructed across the Strait of Canso between the mainland of Nova Scotia and Cape Breton, which will have a clear span of 1,800 feet. Its estimated cost is $5,000,000.

DIFFERENTIAL INDEXING.

METHOD OF INDEXING EMPLOYED ON BROWN & SHARPE MFG. CO.'S UNIVERSAL MILLING MACHINES.

This method of indexing is much simpler than the compound method heretofore employed for obtaining divisions that are prime numbers and others not obtainable with the regular index plates. The indexing is obtained in the same manner as for plain indexing excepting that the spiral head spindle is geared to the index plate. It differs from compound indexing in that the movement of the crank at each indexing is positively modified by the plate, which is geared to the spiral head spindle and moves whenever the crank is moved. The differential motion is thus obtained, allowing the indexing to be made with one circle of holes and the index crank turned in one direction the same as in plain indexing. This enables spacings to be made that cannot be obtained with an index plate locked in the usual way with the stop pin. In the compound method, it is necessary to exercise great care, as two circles are employed and it must be constantly kept in mind as to the direction in which the crank is to be moved, right or left. In the differential method, however, there is little opportunity for error, as the index crank is moved the same as in plain indexing, it being only necessary to place the proper gears in position, as

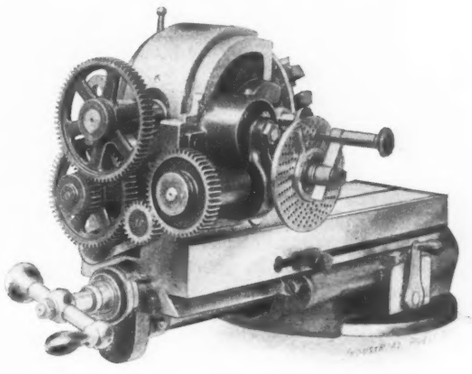


Fig. 1. Indexing for 319 Divisions.

indicated by the table which accompanies the machine. This table is made up to include both plain and differential indexing and avoids the necessity of two separate circles. It gives all divisions from 1 to 360 and the proper change gears and instructions as to placing them. *

As an illustration of the principle of the differential method of indexing, assume the index plate and spindle to be geared together in the ratio of one to one. The plate will then turn once while the spindle turns once. Therefore, if the plate turns in the same direction as the crank, and the crank is turned enough more than a complete revolution at each indexing to have the crank pin go into the same index plate hole, it will be readily seen that one turn of the crank will be in consequence of having followed the plate while the spindle has made one turn. Hence, the worm will have turned 40 turns in 39 indexings, which is equivalent to obtaining 39 divisions with equal gears and using only one hole in the index plate, the regular spacing number being 40 turns of the worm to one of the spindle. If the regular spacing number were 60, it would be possible to obtain 59 divisions with the equal gears.

The use of two idlers with the equal gears will rotate the index plate in an opposite direction to the crank. In this case, the crank, in making 40 complete revolutions, will meet the same hole in the index plate 41 times, thus obtaining 41 divisions by bringing the crank to the same hole in the plate at each indexing. It will, therefore, be readily seen that with only one hole in an index plate, it is possible, by gearing the index plate to the spindle in a ratio of one to one, to obtain 39 divisions with one idler and 41 with two idlers. With one idler, the spacing number is changed to 39 and it is

* This table is reproduced in the data sheet accompanying the Engineering Edition of this month.—EDITOR.

possible to obtain divisions equal to 3 x 39 with a circle of 3 holes, or 4 x 39 with a circle of 4 holes, etc. With the same gearing and two idlers, the spacing number is changed to 41. Any division not obtainable with the index plate can, therefore, be made up with proper gearing.

To explain this method further, the following examples are given:

Required: 59 divisions, no index plate with 59 hole circle being at hand. First, set the indexing for 60 divisions, which is 2-3 turn of the crank at every indexing. With 59 indexings, therefore, there will be obtained 39 1-3 revolutions of the worm, lacking 2-3 turn of the 40 required for one complete revolution of the spindle. With the proper gearing, 2-3 turn can be made up, the gears in this case being 48 on the worm and 32 on the spindle, with one idler. This will give the 59 divisions required, or with two idlers, 61 divisions can be obtained.

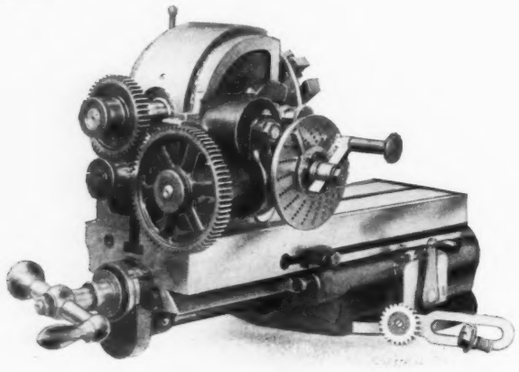


Fig. 2. Indexing for 177 Divisions.

In gearing the index plate to the work spindle, it is necessary sometimes to employ compound gearing, Fig. 1. As an illustration of this method of gearing, take 319 as the number of divisions required. First, select some number of divisions that can be obtained with any index plate furnished with machine; for example, 290, which would require a plate with 29 hole circle, using 4 holes at each indexing, 4/29 turn of the index crank. Indexing 319 times, 4/29, the worm will be turned 44 times, this being 4 turns more than the 40 required for one complete revolution of the spindle. 4 = the number of turns that the plate should make to one turn of the spindle. It can be expressed in the form, $\frac{3 \times 4}{1 \times 3}$; and multiplying the first turn, $\frac{3}{1} \times \frac{24}{24}$, and the second, $\frac{4}{3} \times \frac{16}{16}$, the expression becomes $\frac{72 \times 64}{24 \times 48}$. The terms of this fraction represent the teeth of available gears, the gears, 72 and 64, being drivers, 24 and 48 driven gears. The proper arrangement of these gears is found by referring to the table. Gear on spindle, driver; gear on worm, driven, or the follower. The first gear on the stud is a driver, which drives the worm gear. The second gear on the stud is a follower, being driven by the spindle gear. A collar is provided for use on the spindle to locate spindle gear. In some arrangements of the gearing, this collar is placed outside of the gear next to the nut and in others, back of the gear. For example: in compound gearing, it is placed back of the gear, bringing the gear out against the nut; and in simple gearing, many times it is necessary to place this collar back of the gear, for the reason that the gear may be so large that it will interfere with the gear of the worm sleeve. An example of this is shown in the gearing for 176 teeth. In this case there are two 24 tooth gears on the stud, making the gearing appear as if it were compound; but the two 24 tooth gears really act as a single idler, as they are on the same stud.

Spacing for One-Quarter Degree.—To space for ¼ deg., or 1,440 divisions, first try an indexing of 1/33, which will give a spacing of 1,320. It is sometimes found convenient to multiply the difference between the spacing required and the assumed number of spaces by the assumed indexing, which gives the gear ratio direct. Thus, the difference between 1,440 and 1,320 is 120, which, multiplied by 1/33, equals $\frac{120}{33}$ the required gear ratio; that is, there are 120 spaces to gain. One spacing being 1/33 of a turn of the index crank and 120 spacings required, $\frac{120}{33}$ is the number of turns of the index crank to one turn of the spindle. $\frac{120}{33}$ equals $\frac{40}{11}$. In order to express this ratio in a form that will permit the use of available gears, it is necessary to reduce it as follows: $\frac{40}{11}$ equals $\frac{200}{55}$, which can be compounded into $\frac{8 \times 25}{5 \times 11}$. Multiplying the first term, $\frac{8}{5} \times \frac{8}{8}$, the result is $\frac{64}{40}$; and the second term, $\frac{25}{11} \times \frac{4}{4} = \frac{100}{44}$; and the ratio, or train of gears, becomes $\frac{64 \times 100}{40 \times 44}$. In order to gain the required number of indexings, one idler is required to reverse the index plate in relation to the movement of the crank, which, combined with the compound gear stud, gives the effect of two idlers, for the reason that the gears on the stud act as one idler. The gears, 64 and 100, are drivers, and those with 40 and 44 teeth respectively are followers.

Fractional Spacing.—As illustrating this application, assume that it is required to space a Vernier to read to 1-12 of a degree or 5 minutes; the Vernier to be used in connection with a scale divided to degrees. Usually the method adopted to accomplish this is to have the Vernier spaces occupy a distance corresponding to 11 degrees and to divide this into 12 parts or spaces, which may be expressed as follows:

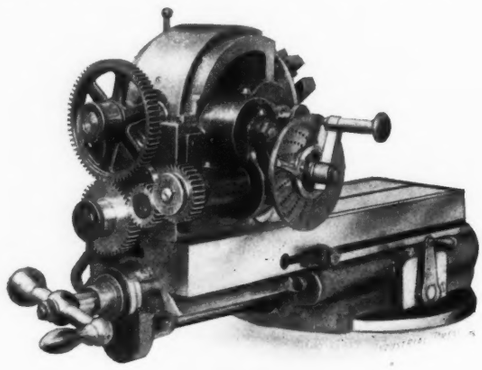


Fig. 3. Indexing for 169 Divisions.

$\frac{11}{360} \div 12 = \frac{11}{4320}$, which is equal to one space. There would, therefore, be $\frac{4320}{11}$ spaces in the whole circle, or 392 8 11 divisions. Indexing of 1/9 or 360 gives the difference between 392 8-11 and 360 or 32 8-11 indexings to be obtained with the gearing. 32 8-11 = $\frac{360}{11}$ indexings, which, multiplied by the value of one indexing, 1/9, gives $\frac{360}{11} \times \frac{1}{9} = \frac{40}{11}$, the resulting gears will be $\frac{200}{55}$ or $\frac{64 \times 100}{40 \times 44}$, one idler being required. It will be noted that the gears called for in this example are the same as those used in the one just previous.

This method of indexing has been applied to all of their universal milling machines by the Brown & Sharpe Mfg. Co., to whom we are indebted for the above description and photographs.

ITEMS OF MECHANICAL INTEREST.

Stud Setter—Cutting Odd Worms—High Pressure Piston Packing—Magnetic Attachment for T-square and Drawing Board—Spindle Boring Machine.

STUD SETTER AND EXTRACTOR.

An English stud setter and extractor of somewhat novel construction was described in a recent issue of the *Mechanical World*. It can be used both for setting studs and for removing them. Broken studs can be removed provided 5-16-inch grip is available. This, of course, applies only when the studs are not "seized" or rusted fast, but are merely broken off in such way that a grip cannot be taken with ordinary tools. A socket *A*, provided with a square *E* to take a tap wrench, is placed over the stud to be removed.

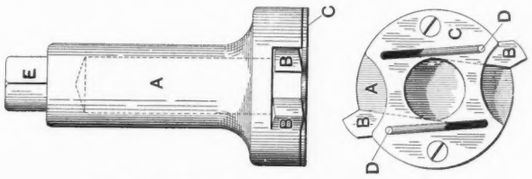


Fig. 1. Device for Setting and Extracting Studs.

The sliding wedges *B B* are then pressed in equally until their serrated edges are in contact with the stud, when by turning the tool by the aid of a wrench the stud is extracted. The stud is removed either by a pipe wrench, or by placing it in the vise and turning the tool in the reverse direction. To change the tool to a stud fixer, the coverplate *C* is removed, the pins *D*, *D*, which are loose in the wedges, pressed through to the other side, the wedges inserted in the reverse position, and the coverplate replaced.

METHOD OF CUTTING WORM OF ODD PITCH.

Under the heading "Workshop Practice" in a recent issue of *Feilden's Magazine* a description is given of the method followed in replacing a worm when it was found there were no change gears to the lathe that would permit its being cut. The new worm casting was bored and keyed on a mandrel along with the old worm. A double-ended toolholder was clamped to the cross slide of the lathe. Into the left end was fitted a cutter for chasing the new worm and into the other end was fitted a steel guide filed to fit the old

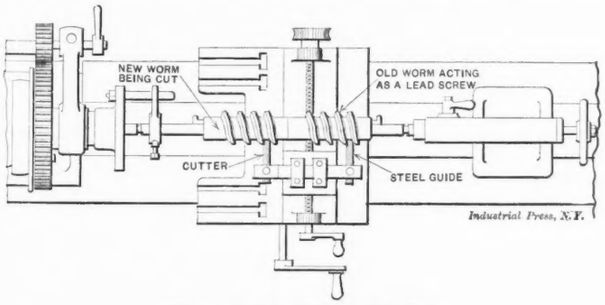


Fig. 2. Cutting Worm of Odd Pitch.

worm, the idea being to make the old worm give the necessary traverse to the lathe carriage for cutting the new worm. All this is clear in the accompanying cut. The steel guide projected ¼-inch further than the cutter when starting the cut; as the successive cuts were taken, the cutter was advanced in the toolholder without moving the cross slide.

HIGH-PRESSURE PISTON PACKING OF ENGLISH DESIGN

Apropos of the articles that appeared on pistons and packing rings in the July and December, 1902, issues, we reproduce from London *Engineering* a short description of Downie's piston packing for high-pressure steam engines, which is in use in some large marine engines, both for the main pistons and for the piston valves. The packing consists of two rings placed side by side in one groove, which is turned wider at the bottom than at the top. The rings are faced flat on their opposing faces and conical on the piston and junk-ring faces. They are cut and sprung into place so as to "break joints." The object of the inclined upper and lower faces is to prevent undue pressure on the cylinder walls because of the steam pressure. By regulating the distance between the junk-ring and the piston, the diameter to which the rings can expand can be controlled. In fitting the rings

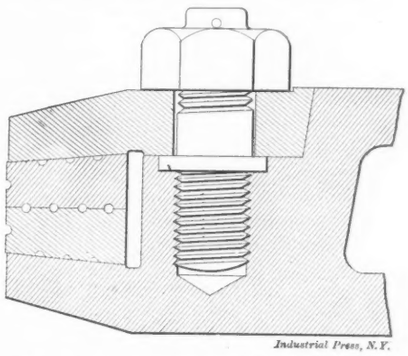


Fig. 3. Piston Packing Ring for High Pressures.

a little slack is allowed so as to let the rings wear to the cylinder, after which it is claimed they remain tight, the slight wear that takes place on the conical surfaces being sufficient to keep them full bore. The grooves shown in the sides of the rings, are evidently for "water packing."

DRAWING BOARD AND T-SQUARE WITH MAGNETIC ATTACHMENT.

An English novelty in drafting room appliances, is a T-square having a number of small horseshoe magnets mounted in the head and so arranged that their poles come in contact with an iron strip attached to the left-hand end of the board, the idea being to hold the T-square to its right-angle position, by magnetic attraction alone. This, of course, allows the draftsman to use both hands at his work more ad-

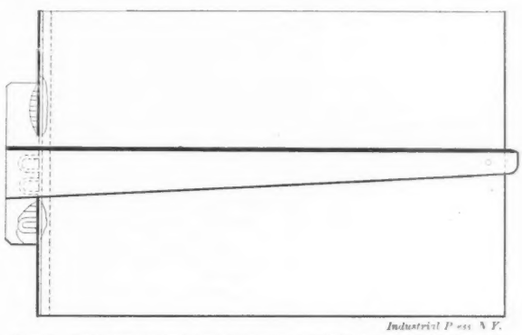


Fig. 4. Drawing Board and T-square with Magnetic Attachment.

vantageously. The magnets are said to oppose little resistance to movement of the blade to any position parallel with its normal position, but considerable force is required to displace the blade from its right-angle position. A drawing board with this attachment may be used in a vertical, sloping or horizontal position with equal facility.

STENCILING COUNTERSHAFT SPEEDS.

Extensive additions are being made to the Juniata Shops of the Pennsylvania R. R., at Altoona, Pa., and many new machines are being installed. Mr. A. Timm, general foreman of the machine shop, writes us that they have been considerably troubled by the neglect of machinery houses to give the speeds at which the countershafts for various machines received from them, should run. The machines received direct from the manufacturers, are usually accompanied by a blueprint or letter giving the proper countershaft speed, and the same information is sometimes given in their catalogues. But the machinery received at these shops from machinery houses, has, in all cases, lacked this quite necessary information. Eight small machines were received from one house in one week, and not one of them was accompanied by the countershaft speed. Of course it is a simple matter to calcu-

late the countershaft speed when the spindle speeds are known, but this all takes time and is entirely unnecessary labor. Mr. Timm suggests that machinery builders generally adopt the practice of stenciling, on the countershaft for each machine, the proper speed at which it is to run. This should make a record of sufficient permanence to insure its reaching the customer, even if the machine has passed through a machinery house.

A MONSTER LEATHER BELT.

An exceptionally large leather belt has been put into place at the power house of the Twin City Rapid Transit Co., at Minneapolis. It was supplied by the W. S. Nott Rubber Company of that city. The belt is 100 feet long, weighs 2,000 pounds, is 80 inches in width and three-ply. There are eight hides to every four feet of the belt, which means that 200 head of cattle—a respectable herd for a small stock farmer—were required to furnish enough leather for this enormous belt.

Throughout the entire process of construction no fasteners of any description were used outside of a special belt cement of high adhesive power. Altogether it took 15 men more than a month to fashion it. The size of the belt gives an idea of the diameter of the big wheel which will before long be furnishing much of the street railway motive power. The largest belt ever built by this company was furnished to the Anaconda copper mine at Anaconda, Mont. It was 180 feet long, 66 inches in width and four-ply. It required 360 hides and weighed 3,600 pounds, driving from a 28-foot diameter pulley to an 87-inch driving pulley. Its speed was 5,000 feet per minute, and it transmitted an average load of 1,800 horse power.—*The Age of Steel.*

* * *

A SPINDLE BORING MACHINE.

Of the different problems with which the machine tool builder is confronted probably none have required more careful attention and experiment than that of boring out the hollow steel spindles used on lathes, boring machines, etc. For this purpose many of the different builders have designed and built their own machines, which are generally admirably adapted to the class of work they are to handle. The photograph illustrates one of these spindle boring machines which has lately been built by the Springfield Machine Tool Co., Springfield, Ohio, for their own use. The construction of the head of this machine is clearly shown in the drawing Fig. 6.

This machine is intended to bore holes from 1 inch to 6 inches in diameter in spindles varying from 1½ inch to 7 inches in diameter. The cone is keyed to a spindle which is geared into the main spindle of the lathe with a ratio of three to one. Back gears are provided so as to give eight different speeds, arranged in geometrical progression.

The most important requisite of a spindle boring machine is a wide range of feeds of ample power. The feed power is taken from the coneshaft and transmitted to a cone the shaft of which is geared into the feed rod. In addition to the use of a five-step feed cone, back gears are furnished so that ten different rates of feed are obtainable, giving a range from .0005 inch to .01 inch per revolution of spindle. Motion from the feed rod is transmitted to the carriage by means of a train of gearing and a pair of rack pinions which engage in a pair of steel racks, one of each being located on the top of the bed and at the side of the V's, upon which the carriage travels. This arrangement makes a much steadier feed than could be obtained if only one rack were used, as is customary in engine lathe construction. The feed is engaged or disengaged by means of a powerful friction which is so designed that it will slip should any unusual resistance be encountered. A pilot wheel, keyed to a rack gear shaft provides for a quick return of the carriage.

A duplex single-acting pump supplies a constant stream of oil, which is essential to the proper working of the drill.

As will be noted the spindle of the machine is hollow, which permits of holding the spindles to be bored, at one end with the universal chuck and at the other end with suitable collars which must fit the ends of the spindle that is being bored and the bore of the machine spindle. This construction enables a comparatively short machine to be used for boring long spindles, whereas if one end of the spindle were to be held in the chuck and the other end in a bearing or steady rest, the length of this machine would require to be almost doubled. A rest is provided which guides the boring tool at the commencement of the cut and after a hole has been drilled a short distance, say 2 inches or 3 inches, it may be removed by being swung out of position.

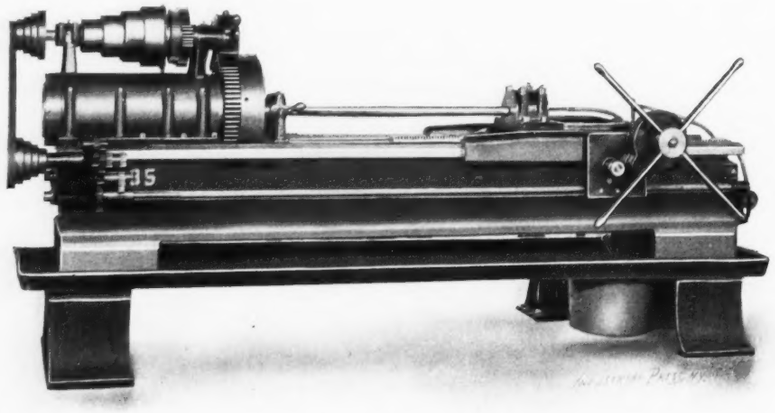


Fig. 5. Machine for Boring Spindles.

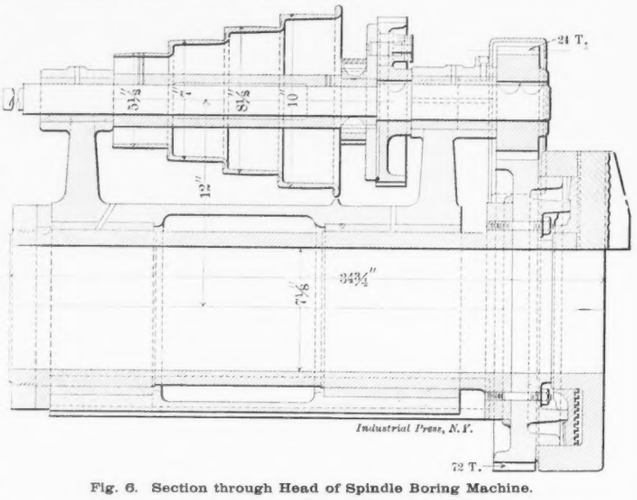


Fig. 6. Section through Head of Spindle Boring Machine.

The carriage has a travel of 5 feet, and therefore, permits of boring a hole 5 feet in length without re-setting the boring bar, and as ample provision is made for this purpose, it is possible to bore holes 7 feet or 8 feet in length without turning them end for end.

* * *

According to a short article recently published in the *Electrical World and Engineer* the thawing of frozen water pipes appears to be a regular winter industry in Sault Ste. Marie. A transformer is mounted on a sleigh and hauled around town to wherever frozen pipes may be. Connection is made to the pipes each side of the frozen section with the secondary wires from the transformer and the primary wires are connected to the 2,200 volt circuit, through a water rheostat. The water generally begins to flow very quickly after the current is turned on, usually within one minute. Pipes as large as 4 inches diameter and frozen more or less for 200 feet, have been thawed out in this manner and at a fraction of the cost of following the usual plan of digging. That the business is profitable may be inferred from the usual charge being about $3.00 for thawing house pipes.

A FORTY-FOUR FOOT PIT LATHE.

DESCRIPTION OF LARGE FRICTION DRIVEN LATHE.

Paper read before the American Society of Mechanical Engineers, December, 1902, by John M. Barnay.

The machine here illustrated was designed to meet the demands of an establishment manufacturing the heaviest type of electrical machinery. The ever-increasing dimensions of this class of machinery make it particularly desirable that the existing heavy machine tools should be capable of extension of capacity with a view to probable future requirements; and that a pit lathe is peculiarly adapted to such extension will, doubtless, be readily admitted.

The faceplate of this lathe measures 30 feet in diameter, and the present dimensions of the pit will admit of swinging 44 feet on centers, with a maximum width of 12 feet. The large faceplate is built up of twelve segments. The rim is of box section, the ends of the rim in each section being finished to make the joint, and the segments being held together at the rim by body-bound bolts. The arms are slotted for bolts, and the space between segments is also shaped to receive the usual square-headed bolts, as the inner end of each segment is fastened to the smaller faceplate by several body-bound bolts. The smaller faceplate is cast integral with the forward section of the spindle which revolves in a babbitted bearing 48 inches in diameter by 68 inches in length, the rear bearing being 22 inches in diameter and 28 inches long. It is calculated that the pressure on the main bearing will, at times, attain a maximum of 125 pounds per square inch.

Teeth were cast into the periphery of the 12-foot faceplate for the purpose of driving same while turning out the spindle bearing. After the spindle was finished by this method the segments of the large faceplate were bolted on, the spindle assembled on the headstock, and the periphery of the 30-foot faceplate turned off, with the spindle in its own bearing.

A novel feature of interest in connection with this machine is the method of drive adopted, which is a friction roller, 18 inches in diameter, made of compressed paper, while the rim of the large faceplate, 15 inches wide, affords the necessary contact surface for driving. Power is supplied by a 75 horse power motor, quadruple geared, the use of the multiple voltage system giving the machine a range covering all diameters from six feet to the present capacity, though the gear train is designed to admit of two changes of back gear in addition.

The tool carriages are supported on massive cast-iron columns resting on the bottom of the pit, and the feed mechanism is driven by an independent motor properly back geared. By the use of the multiple-voltage controller, and a device called a feed regulator, at rate of feed from 3-64 inch to 2¾ inches per minute can be had without a change of back gears. There was also designed for this machine an outboard bearing to support the outer end of mandrels and boring bars which is provided with a geared sleeve connected to a train of back gears driven by an independent motor; the whole being self-contained and constituting a portable boring and facing tool. An approximation of the total amount of cast iron used in the construction of this machine places the weight at 480,000 pounds, of which the spindle and two faceplates together weigh about 155,000 pounds.

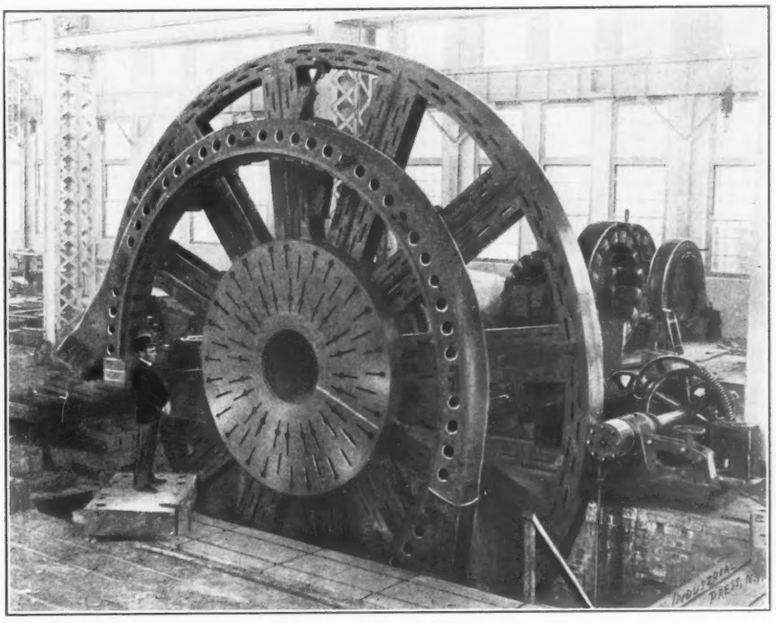
As would be expected in this class of tool, the center of gravity of the revolving parts lies very close to the edge of the pit; hence, the matter of a substantial foundation became one of considerable importance, and to meet the severe requirements the design of the headstock provides a large area for the distribution of this pressure, so that the forward part of the headstock alone covers an area of 68 square feet. The masonry foundation consists of a layer of best Portland cement grouting on top, surmounted by a five-foot layer of vitrified brick which, in turn, rests on a massive column of best pressed brick, all laid in first quality of Portland cement.

[In connection with the above-described machine Mr. Barnay furnishes us the following data regarding the power required for operating and the power transmitted by the friction wheel.—EDITOR.]

The weight of the revolving parts of the pit lathe alone is about 155,000 pounds. Add to this the weight of the casting bolted to the faceplate and we have 210,000 pounds. The diameter of the main bearing of the spindle equals 48 inches. The number of revolutions of the spindle during the operation of boring was ¾ revolution per minute, representing a cutting speed of 45 feet per minute. Assuming a coefficient of friction of 0.10 for the bearings, we have power required to drive machine with casting bolted to faceplate, but without cut.

$$\frac{210{,}000 \times 48 \times 3.1416 \times .10}{12 \times 33{,}000}$$

equals 8 horse power, nearly. To this is to be added the power required to run three cuts each ¾ inch deep with ⅛ inch feed. At forty-five feet per minute cutting speed this is equivalent to removing 64¼ cubic inches of metal per minute. Assuming that it takes 35-100 horse power to remove one cubic inch of cast iron per minute, a good average, as established by numerous independent tests, we have power required to take three cuts as above, about 22½ horse power.



Friction-driven Pit Lathe.

Then 8 plus 22½ equals 30½ horse power, which is the total horse power transmitted by the friction wheel at the surface speed of 74¼ feet per minute.

Now let us compare this result with such published formulæ as have been found available on this subject. Taking, for instance, Prof. Goss' formula published in the transactions, A. S. M. E., XVIII, pp. 102. According to this formula horse power equals .000238 D. W. N., in which D equals diameter of wheel in inches; W equals width of wheel in inches; N equals number of revolutions per minute.

Applying this to our case, we have, D equals 18; W equals 15; N equals 15¾; .000238 D. W. N. equals 1.012 horse power.

As Prof. Goss' formula is based on pressure of contact of 150 pounds per inch, it would follow that the pressure of contact in our case is 150 : X :: 1.012 : 30½, which gives 4,525 pounds.

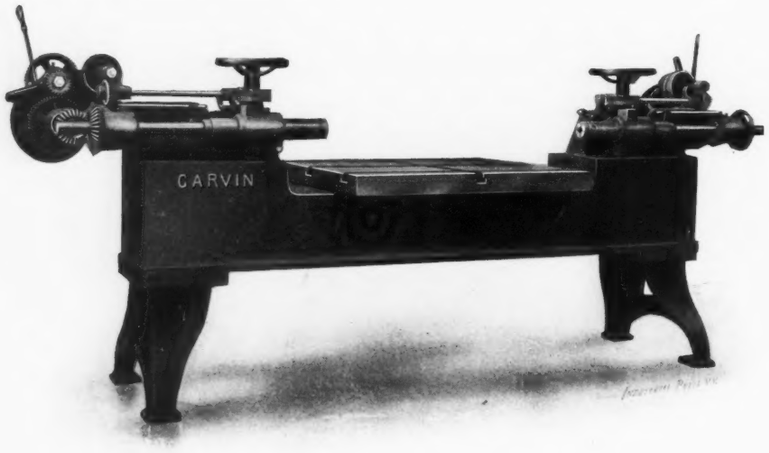
In justice to the author of the above formula it should be said that it was probably never intended to apply at such extremely low surface speeds. As stated in his paper, the experiments conducted at the time of the establishment of the formula covered surface speeds between 400 and 2,800 feet only.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

DUPLEX DRILL LATHE.

A special manufacturing tool that is simple in construction and well adapted to its work is shown in the accompanying half tone. This is a duplex drill lathe and is used for drilling, through jig eyes, such work as hinge holes in fire doors and their frames, sewing machine treadles, machine frames girths, etc. On either end of the lathe bed is mounted a drill spindle similar in construction and operation to that of an ordinary vertical drill. These spindles are independent, have a light, quick hand movement to and from the work and are

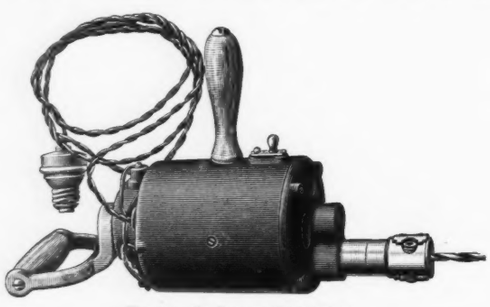


Duplex Drill Lathe.

provided with power feed and adjustable automatic trip. Each spindle is driven by a four step cone from an independent countershaft, and is back-geared, giving eight changes of speed. The work is held on a heavy T-slotted table on which are also placed the jig eyes and fixtures used for directing the drill. The table is of ample size for handling large work, while for drilling small pieces extension drills are used. In the machine illustrated the distance between the heads is 46¾ inches and the height of the center of spindles above the table is 5¼ inches. These dimensions may be altered to meet any desired requirements. This machine is the product of the Garvin Machine Co., New York.

ELECTRICALLY DRIVEN HAND DRILL.

The portable electrically driven hand or breast drill here illustrated is likely to prove of great convenience in any shop where it is used to replace the ordinary hand drill. Owing to its greater speed it performs the work much more rapidly than

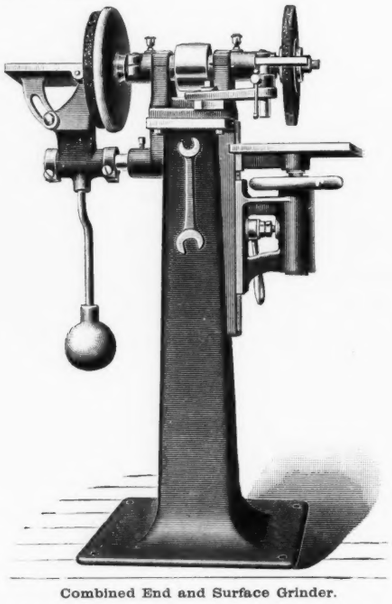


Electrically Driven Hand Drill.

it could be done by hand, besides saving the strength of the operator. The power is supplied by connecting the flexible wire cord to any convenient incandescent lamp socket, and the range of operation is limited only by the length of the cord. The drill is under perfect control at all times as a switch is provided, where it is within easy reach of the index finger, for starting or stopping the motor. This machine is made by the Hisey-Wolf Machine Co., Cincinnati, Ohio, and is supplied in three sizes, taking drills up to ¼ inch, ⅜ inch and ½ inch respectively.

NEW END AND SURFACE GRINDER.

The illustration shows a grinder, for end and surface work, that is made by the Rowbottom Machine Co., Inc., Waterbury, Conn. This machine possesses features that make it especially helpful for tool and press room work and for a variety of purposes in manufacturing.



Combined End and Surface Grinder.

The table on the right is counterbalanced and provided with a quick method of adjustment for wide ranges by the lever shown under the table. By lifting up the lever the table is released and is free to move either up or down, by pressing the lever down the table bracket is firmly fastened to the column; the handwheel under the table is then available for fine feed. On the left is a swinging table for end grinding by swinging the work across the face of wheel; this table is adjustable for angular work and is provided with adjustment to keep it close to the wheel. The emery wheels for end grinding may be replaced by emery cloth disks or the machine can be provided with both, as the change is readily made from one to the other, thus allowing the machine to cover a large range of grinding. The bearings are dust proof with adjustment for taking up wear, and oiling devices are provided.

The emery wheels are 10 inches diameter and the emery cloth discs 12 inches diameter. The table for surface work is 16 inches long by 10 inches wide, with up and down adjustment of 8 inches and is capable of surfacing 8 inches wide.

LOWE TEST INDICATOR.

Fig. 1, on next page shows a test indicator that has been brought out by H. A. Lowe, Waltham, Mass., and which, owing to the convenience of its manipulation, will be found useful for an unlimited number of purposes in the machine shop.

The shank of this indicator is 7-16 inch by 15-16 inch and is carried in the tool post of the lathe. Being casehardened it is not injured by the tool post screw, and at the same time the channel shaped section of this shank affords protection to the delicate working parts.

The forward end of the holder terminates in a point bearing a pivot about which oscillates a lever the short arm of which is placed in contact with the work to be indicated. The long arm of this lever runs back to a spiral groove in the vertical pointer spindle. This arrangement causes the pointer to revolve over a horizontal graduated disk mounted on the back end of the holder. This disk is graduated to read in thou-

sandths of an inch of movement of the short lever arm and the leverage is such that any movement of the short lever is multiplied one hundred times by the pointer. A flat spring, placed under the long arm of the indicator, keeps the pointer normally at the zero position. This tool may be applied to testing shafting, flanges, gears and all kinds of lathe work, and is also used in the planer and shaper for setting angle plates and work

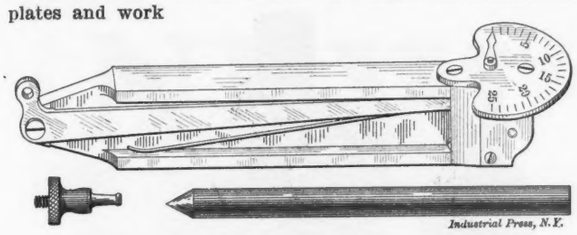


Fig. 1. H. A. Lowe's Test Indicator.

When the indicator is to be used for internal work the screw button, shown beside it in the cut, is inserted into the eye of the short arm and the point of this button is placed in contact with the inside of the hole. This is illustrated in Fig. 2, which shows the indicator in use for re-chucking a gear so that the hole will run perfectly true. The pointed rod, shown just below the indicator in Fig. 1, is used for

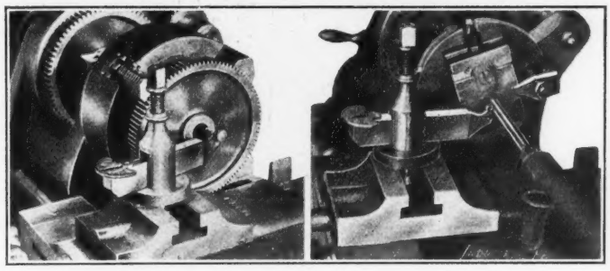
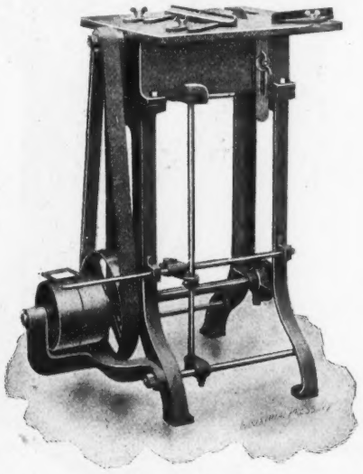


Fig. 2. Re-chucking Gear by Hole. Fig. 3. Setting Jig on Faceplate.

"wiggling up" or locating work on the faceplate central to a prickpunch mark. One end of this is fitted with a female center which is placed on the tail center of the lathe while the point is placed in the prickpunch mark in the work which is held on the faceplate. Then by use of the indicator, as shown in Fig. 3, the work may be quickly brought to a central position on the faceplate.

THE ACME METAL SAW TABLE.

This saw table is the invention of Mr. F. D. Hazelton and is being placed on the market by Hazelton and Donald, Philadelphia, Pa. The table is the result of the inventor's needs for



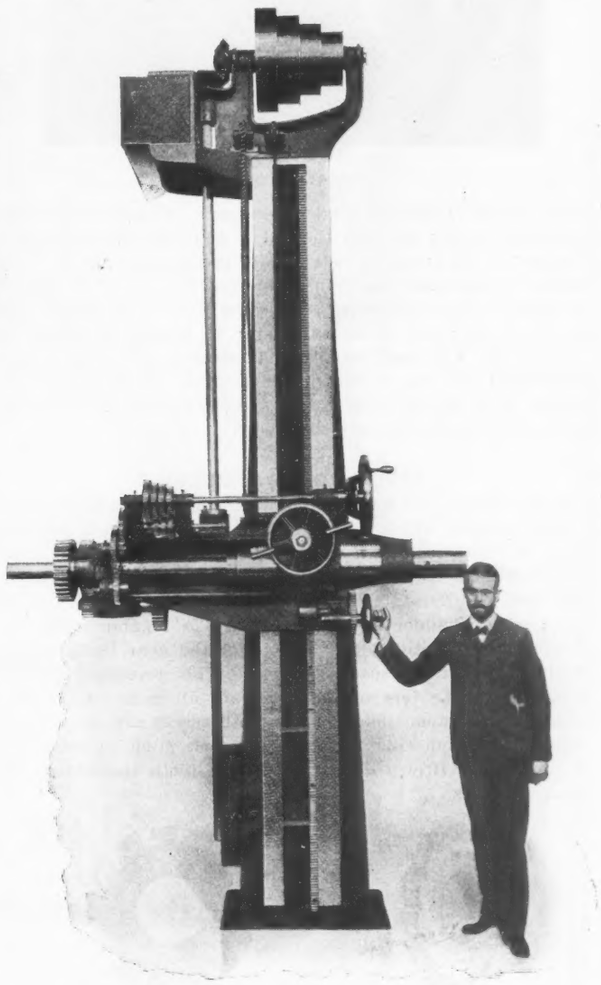
Acme Metal Saw Table.

a saw for cutting sheet, rod and tube brass, fiber, hard rubber, printers' furniture and electrotype plates. The machine occupies a floor space of but 18 x 24 inches, is constructed wholly of metal and is self-contained. One important feature is that the saw arbor is but one inch below the surface of the saw table, thus permitting the use of saws of small diameter and consequently obtaining the greatest power and accuracy. The table swings entirely open or may be set to saw any desired depth while the slitting gage may be adjusted for slitting any width up to 12 inches. The cross cut gage will swing either way to any practical angle. An improved device is provided for holding the arbor from turning while attaching or removing the saws. A removable throat plate allows the use of wood cutting saws up to 6 inches in diameter.

A DRILLING AND BORING TOOL FOR STEAM ENGINE WORK.

The accompanying half-tone illustrates an interesting special machine, for use on large steam engine work, that was recently built for the W. A. Harris Engine Co., Providence, R. I., by the Prentice Bros. Co., Worcester, Mass.

This machine was designed for boring up to 36 inches in diameter and is capable of drilling from the solid up to 6 inches. The base is bolted to a cement foundation while the

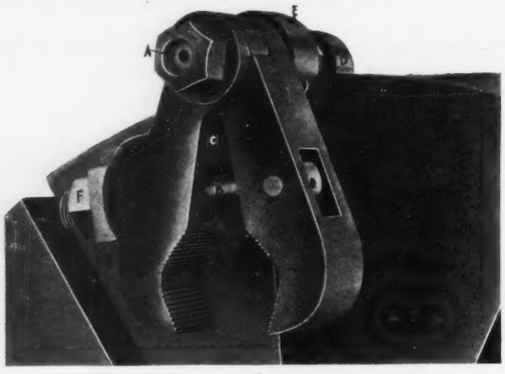


Prentice Bros. Co.'s Special Drilling and Boring Machine.

top is of suitable shape to fasten to the overhead timbers of the shop. The total height of the machine from the base to the top of the cone pulley is 14 feet 4 inches. This allows the spindle to be raised to a maximum distance from the base of 10 feet 6 inches, or it may be lowered to a height of but 14 inches. The head is counterbalanced and its vertical movement in the upright is facilitated by the employment of compound gears. The spindle, which has a horizontal traverse of 23 inches, has four changes of geared feed, hand feed, and quick return motion. This machine can also be used for vertical milling, feeding by hand through the compound gearing.

A NEW LATHE DOG.

A new lathe dog which is manufactured by the Eddystone Engineering Works, Eddystone, Pa., is illustrated in the accompanying cut. This dog has two jaws which are pivoted about a central stud, *A*, and grasp the work in the open ends, A bolt, *B*, tightens the jaws onto the piece being turned and when this bolt is released the spring *C* spreads them apart and the work is at once released. The steel about which the jaws pivot has at its lower end a T-head *D* and clamping nut *E*, so that it can be firmly clamped at any point on the faceplate. In use, this stud is slid into one of the faceplate slots, as shown in the cut, and the jaws are brought down over the



New Lathe Dog.

work, which is held on the lathe centers. The jaws are then tightened on the work by the nut *F* and the driving stud is clamped to the faceplate by a turn of the spanner nut *E*. This makes a rigid and powerful clamping dog which is easily operated. When removing the work and introducing new pieces, if they are of the same size, it is only necessary to operate the bolt that clamps and releases the jaws as the stud holds the dog in the proper position for receiving the pieces. This dog is made in four sizes capable of taking work from 1 inch to 12 inches in diameter.

SPECIAL GEAR CUTTERS.

R. M. Clough, Tolland, Conn., is making two forms of gear cutters, one of which, we believe, is distinctly new and the other is so little known that it will be of interest to most mechanics who may be more or less familiar with gear cutting. The first-mentioned cutter is that shown in Fig. 1. It is made with shoulders at the sides of the regular teeth, for the purpose of milling off the tops of the gear teeth as the cutting of the tooth spaces proceeds. This saves turning the blanks since the tops of the teeth are all milled to correct length at the same time that the tooth spaces are cut. These cutters are made eight in a set for each pitch to cut gears of the regular Brown & Sharpe involute tooth shape, from 12 teeth to a rack.

Fig. 1.

Fig. 2.

The cutter shown in Fig. 2 is for cutting bevel gears at one cut for each tooth which, of course, saves at least one and usually two cuts for each tooth, when done in the ordinary way. This cutter is, to all intents and purposes, a 22½ degree involute cutter, and is made eight cutters to a set for each pitch, for either spur or bevel gears. It is thinner on the points of the teeth than a Brown & Sharpe, or 15 degrees involute cutter, and is used by setting the gear at such an angle as to "shallow" the small ends of the tooth spaces the proper amount. The gears produced in this manner are said to run fully as well as when cut with three operations for each tooth, and the teeth are so shaped as to be somewhat stronger than the ordinary bevel tooth of the same pitch. Firms that are using these cutters prefer the gears to those cut in the ordinary way, to say nothing of the decreased cost.

AUTOMATIC GEAR AND RACK CUTTERS.

The Dwight Slate Co., Hartford, Conn., have recently redesigned and improved their gear and rack cutters in a manner

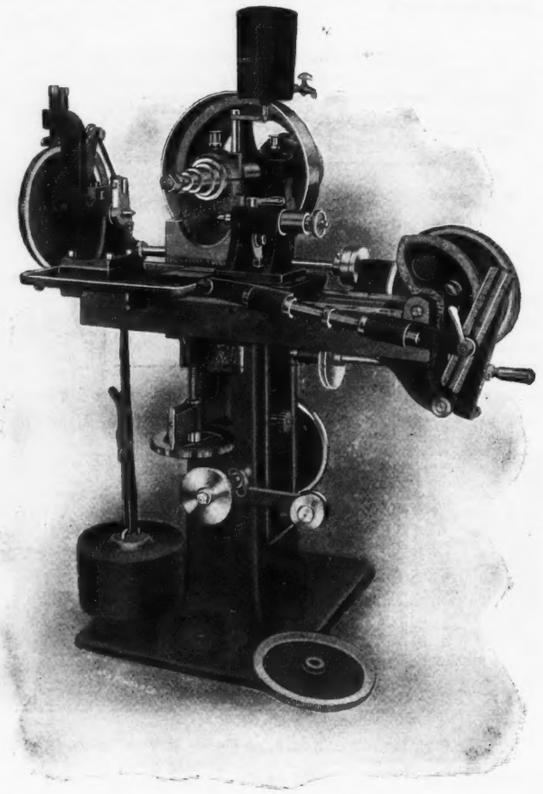


Fig. 1. Improved Automatic Gear Cutter.

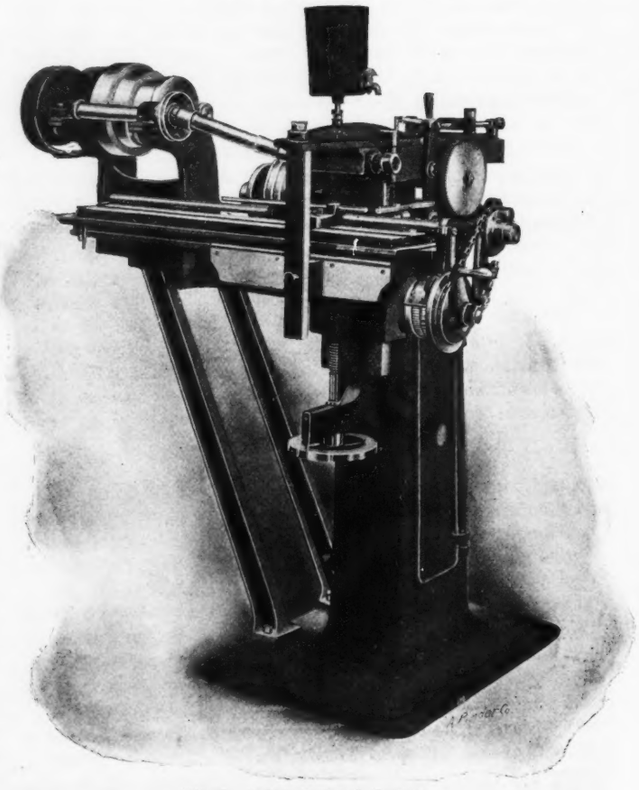


Fig. 2. Automatic Rack Cutter.

tending to simplify their operation and increase the production. In their automatic gear cutters of earlier design it

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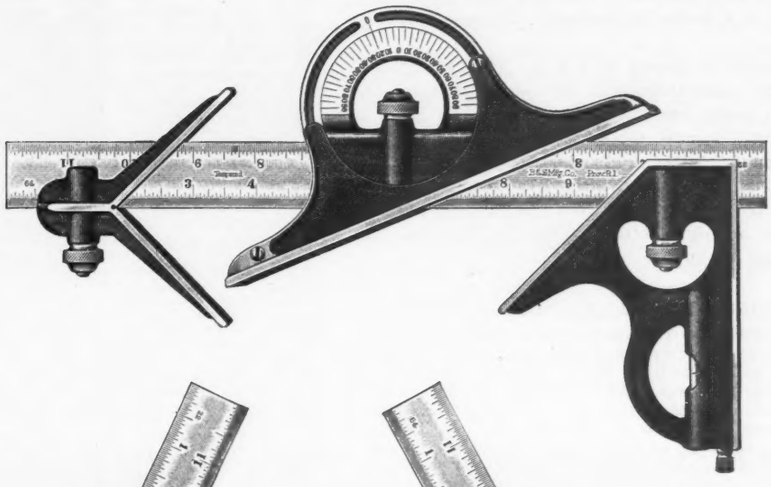

The "B&S" Protractors

The "B & S" Combination Sets

POINTS OF SUPERIORITY—*Square Heads* of Steel, drop forged. *Clamping Groove* round, no sharp corners, forces blade against side of slot square with face of head. *Blades* accurately graduated, have shaded figures that are quickly read. *Protractor Heads* engine divided to 90 degrees either side of zero; Level furnished with head, accurately set parallel to face. **ALL PARTS INTERCHANGEABLE.**

B·S **A Convenience**—Our tools carried in stock by hardware dealers. B·S

CATALOGUE NO. 103 MAILED TO ANY ADDRESS.

was necessary to change the cams that regulated the length of the cut, three cams being required for each machine. In the new machines one cam only is used and this, in connection with the oscillating arm, can be readily adjusted to give any required length of cut within the capacity of the machine. In operation the arbor, carrying as many blanks as can conveniently be placed thereon, is put on the centers and the machine started. Once put in motion, the cutting will continue until the completion of the last tooth, when the feed motion will be tripped out of engagement. After the completion of each cut the table is returned to first position automatically and at the same time the index is unlocked, moved to the proper spacing and securely relocked. Fig. 1 illustrates the No. 2 machine which is capable of cutting gears of 6 pitch and finer up to 8 inches in diameter; extreme length of cut 4 inches. The No. 1 machine cuts gears of 12 pitch and finer up to 4 inches in diameter; extreme length of cut 3 inches.

The new rack cutter is shown in Fig. 2. This machine as formerly built was semi-automatic, the operator being required, after each tooth was cut, to feed the head back by hand and space for the next tooth. It has now been made into a full automatic cutter and when the work is once started it will continue without attention, until the entire rack is cut. This machine will cut racks of 12 pitch or finer, 19 inches long at a single setting, while by resetting any length of rack may be cut.

THE NEW YORK NATIONAL EXCHANGE BANK.

The New York National Exchange Bank, corner of Chambers Street and West Broadway, has just completed a number of improvements and additions which greatly increase its facilities for doing business, and a happy combination of practical experience and good taste has combined not only to utilize every foot of space, but to decorate the new banking rooms so that they equal in attractiveness any in New York—a comparison not to be lightly made.

The screen work forming the partitions is constructed of Pavanozza marble up to the counter level, above which the partitions or cages are constructed in bronze metal finished in verde antique, the interiors being fitted with latest improved counter systems including filing cases of all kinds. The wood work and furniture are of Mexican mahogany and walls finished with green burlap which makes a pleasing contrast with the other fittings. The vaults are constructed with heavy steel linings, inside and outside vestibule doors, and the reserve fund is further protected by being contained in two massive chests of the heaviest construction; the whole controlled by time and combination locks of the latest design.

The New York National Exchange is an old and well-known bank, organized in 1851, and for many years conducted on what may be termed old-fashioned methods; until, about three years ago the management was undertaken by younger and more active men, who have increased its business and resources with such rapidity as to attract the attention of the down town business community. During the period referred to the total resources have moved up from about $2,000,000 to over $7,000,000. The officers of this institution are James Rowland, president; Lewis E. Pierson, vice-president; and Rollin P. Grant, cashier.

* * *

FRESH FROM THE PRESS.

DIES: THEIR CONSTRUCTION AND USE. By Joseph V. Woodworth. Published by Norman W. Henley & Co., 132 Nassau St., New York. 384 8vo. pages. Illustrated. Price, $3.00.

This book treats of tools for sheet metal working. Its pages contain descriptions, with illustrations, of dies, press fixtures and sheet metal-working devices, from the simplest to the most intricate, and the author has described their construction in a clear manner, so that any good mechanic will understand how to design, construct and use them. Mr. Woodworth is a practical toolmaker and diemaker and has become well known through frequent contributions to MACHINERY and other technical papers, and his book on dies is the outcome of his work in this direction. Its various pages contain the articles that he has contributed to the different papers, thoroughly revised, and re-written where necessary, with a great deal of additional matter. The volume is largely the result of Mr. Woodworth's own experience, supplemented by material gathered through observation in different metal-working establishments.

There are twelve chapters in the book, as follows: Single or blanking dies, and double or piercing and blanking dies; simple dies for use in machine shops; gang and follow dies; the adaptation and use of simple dies and press fixtures; bending and forming dies; perforating dies; curling, wiring and seaming processes; drawing processes, for sheet-metal shells; coining processes—operations on heavy stock; feeding sheet metal to the dies; annealing, hardening and tempering—the use of files; miscellaneous dies, presses and fixtures.

This is the most elaborate treatise that has appeared on sheet metal work, and there is probably not a diemaker or a toolmaker who would not find some information of value within its pages. There are over 500 illustrations, most of which are wax engravings made from original drawings by Mr. Woodworth. The development of sheet metal working has been so rapid during the past few years that most mechanics have not had the opportunity to keep pace with the construction of the tools used in such work and the author has done well to gather together so large a fund of information upon the subject, where it may be readily referred to.

ADVERTISING LITERATURE.

THE GRANT GEAR WORKS, Boston, Mass. Circular and price list of machine chains and sprockets.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet descriptive of graphite facings for flat molding and stove plates, for dry sand work, for green sand, etc.

THE GARVIN MACHINE CO., Spring and Varick Sts., New York. General catalogue G of universal milling machines, plain and vertical milling machines, Lincoln milling machines, grinders, screw machines, drills, slotters, etc.

THE PAYNE CO., Inc., Elmira, N. Y. Bulletin No. 12 of Payne engines, for electric light and power service. These are either belted or direct-connected, and several views of this engine are given, also views of the parts.

THE BURT MFG. CO. Akron, O. Pamphlet entitled "The American Oil Filter," describing and illustrating the oil filter and purifier manufactured by this company. The Burt exhaust head is also mentioned.

PAWLING & HARNISCHFEGER, Milwaukee, Wis. Bulletin No. 12, which describes the standard I-beam trolleys built by this company. Chain block traveling cranes, and electric traveling cranes and hoists are also described and illustrated.

THE SHELBY STEEL TUBE CO., Pittsburg, Pa. Price list No. 12, Nov. 1902, of the Shelby cold-drawn seamless steel tubing for mechanical and engineering purposes. Hot rolled tubes are also manufactured by this firm.

THE ARGUTO OILLESS BEARING CO., Wayne Junction, Philadelphia, Pa. Catalogue of Arguto oilless bearings to be used in friction or loose pulleys, on shaft bearings, in friction clutch pulleys, on countershafts, etc. They are applicable to light or highspeed machinery where lubricants are undesirable, but not for heavy work. An abstract from the report of the Franklin Institute on Arguto oilless bearings is published in the back of the catalogue.

THE PRATT & WHITNEY CO., Hartford, Conn. Standard size catalogue, Dec. 1902, describing the thread milling machine recently placed on the market by this company. This machine is built for the production of precision screws, worms, lead and feed screws, etc. The various parts are shown in detail, and four handsome half-tones illustrate the work, large and small, that it is capable of turning out. Various useful tables in connection with this work are given. The Pratt & Whitney automatic cutter grinder is also shown.

THE REEVES PULLEY CO., Columbus, Ind. General catalogue of the Reeves variable speed transmission. This catalogue, just issued, is standard size and profusely illustrated by half-tones and line drawings. The Variable Speed Transmission and its operation are described in detail, and two fine illustrations show clearly the workings of the different parts. Sizes from Nos. 0 to 12 are illustrated and a number of sketches show the application of variable speed to planers, shapers, lathes, milling and boring machines, drills, etc. Several testimonial letters are published and also price lists of the variable speed. The company also publish the "Paper Machinery" issue, which treats of variable speed transmission more at length.

MANUFACTURERS' NOTES.

THE National Tool & Stamping Co., is the name of a new concern erecting a factory at Wayne Junction, Philadelphia, Pa. They will manufacture special tools and dies, and do general sheet metal stamping.

THE Resck Machine Tool Co., Cleveland, O., are erecting a three-story brick factory building on Quincy and Craw Sts., for the manufacture of machine tools and steel balls, the latter formerly manufactured by the Cleveland Ball & Screw Co.

THE Q. & C. Co., Chicago, Ill., recently made a shipment from their factory at Chicago Heights, of one of the largest special metal sawing machines to the United States government, to be used at the Cavite Navy Yard, Manila.

J. T. SLOCOMB & Co., Providence, R. I., have just put out a new morocco case, plush-lined, to hold their Nos. 1, 2 and 3-inch machinists' set, listed as No. 21. The special advantages of this case, which is illustrated in their advertisement in this number is that it can be readily laid in the tool box.

THE name of the system of cost keeping devised by W. S. Rogers has been changed from "Universal Cost System" to "Industrial" Cost System. For information about this system Mr. Rogers should hereafter be addressed care The Bantam Mfg. Co., Bantam, Conn., instead of Keene, N. H.

THE Joseph Dixon Crucible Co., Jersey City, N. J., published in their December number of "Graphite," an article on the experiments of Prof. W. F. M. Goss, of Purdue University, on the use of Dixon's graphite in air-brake equipment. These experiments are not only interesting but of value to all who have to do with locomotive engineering.

MR. DANIEL W. PEDRICK is no longer connected with the Pedrick & Ayer Co. His entire time and attention are now given to the H. B. Underwood Co., of which firm he is the senior partner. He has been a partner of this firm since its organization, and is superintending the turning out of high-grade portable cylinder boring bars and other portable tools for railway repair shops for this firm.

GEORGE WILLIAM HOFFMAN, 295 East Washington St., Indianapolis, Ind., manufacturer of the U. S. Metal Polish and "Barkeeper's Friend," informs us that the demand for his product has greatly increased this year. This paste is sold in powdered and fluid form and is used for polishing gold, silver and plated ware, nickel, tin, brass, copper, etc.

THE FOX Machine Co., Grand Rapids, Mich., manufacturers of wood-working machinery, have just completed a four-story addition to their plant. They have purchased a larger engine, increased the boiler capacity and erected a new pattern storage building. They report that they have found these additions necessary owing to their rapidly increasing business.

THE Crocker-Wheeler Co., Ampere, N. J., manufacturers of electrical machinery, report the shipment of eighteen orders for engine type generators of various sizes, to different parts of the United States. They state that their new mill building is now being occupied, enlarging their floor space by 60,000 square feet, and giving increased facilities for prompt deliveries on large orders.

W. S. ROGERS, formerly of the Roller Bearing and Equipment Co., Keene, N. H., and of the Ball Bearing Co., Boston, Mass., has become the general manager of the Bantam Mfg. Co., Bantam, Conn. This company was organized two years ago for the manufacture of ball and roller bearings and under Mr. Roger's management will make the regular line of goods formerly manufactured by the companies at Keene and Boston.